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NEW HYMENOPTERA FROM THE MALAYAN REGION

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ONE TEXT FIGURE

In identifying some Philippine Hymenoptera submitted by Prof. C. S. Banks, of the Philippine Bureau of Science, certain new species were found. Descriptions of these are included in the following pages. In reporting on this material it seemed advisable to add descriptions of certain related species, and the descriptions of new species from Singapore are also included. The types of all the forms here described are in the United States National Museum.

CHALICIDIDÆ

Genus DIRHINUS Dalman

The genus *Dirhinus* Dalman in current classifications is separated from *Eniaca* Kirby by the number of antennal joints; *Dirhinus* is said to have 12-jointed antennæ, while the antennæ of *Eniaca* are described as 13-jointed. A careful examination of the genotypes shows that these characters have been inaccurately described and that, although there is a difference in the antennæ, this difference does not consist in the number of joints but rather in the relative length of the third joint. In *Dirhinus* the third joint is very short and easily overlooked, while in *Eniaca* the third joint is long and plainly visible. The differences in the antennæ of the two genera are illustrated in the accompanying figure (fig. 1). From an examination of the

specimens in the United States National Museum I was unable to find any other characters which might be considered of generic value and, although I doubt the advisability of considering such

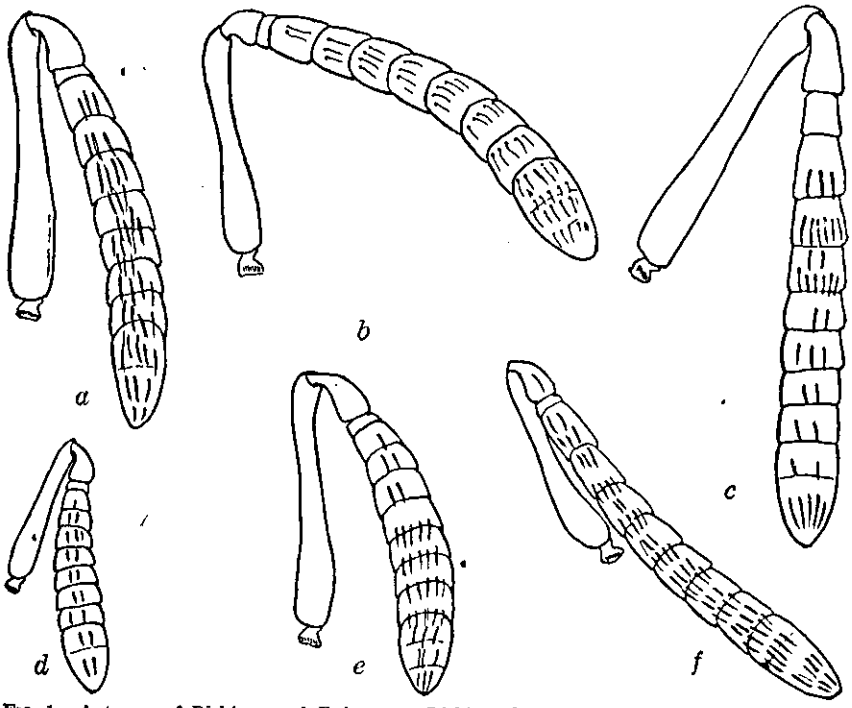

FIG. 1. Antennæ of *Dirhinus* and *Eniaca*. *a*, *Dirhinus luciliae* sp. nov. (type); *b*, *D. excavatus* Dalman; *c*, *Eniaca hesperidumi* Rossi; *d*, *D. banksi* sp. nov. (type); *e*, *D. luzonensis* sp. nov. (type); *f*, *D. auratus* Ashmead, male.

differences in the antennæ as generic, it seems undesirable at the present to suppress the name *Eniaca*. Until more material of this group can be studied I suggest that *Eniaca* be treated as a genus and distinguished from its ally *Dirhinus* as follows:

Third antennal joint at least twice as wide as long, not sharply separated from fourth..... **Dirhinus Dalman.**

Third antennal joint longer than wide, easily seen, and separated from fourth ..... **Eniaca Kirby.**

Key to Philippine species of Dirhinus in collection of the United States National Museum

1. Scutellum with uniform umbilicate punctures; antennæ and four anterior legs red..... **D. auratus Ashmead.**
   Central portion of scutellum smooth and shining..... 2.
2. Pronotum uniformly closely punctured; seen from above the horns of head have a small tooth apically; four anterior legs piceous.
   D. banksi sp. nov.

Pronotum shining, with large well-separated punctures; seen from above the horns of head are evenly rounded; four anterior legs reddish..... 3.

3. Posterior orbits uniformly punctured; vertex with large uniform punctures; antennæ rufous..... **D. luzonensis sp. nov.**

Posterior orbits with umbilicate punctures anteriorly, and with fine punctate granulations posteriorly; vertex with depressed area (which is finely granular) extending obliquely and along the line of the projected lateral carina of frontal horn; flagellum piceous.

D. luciliae sp. nov.

The only species of *Dirhinus* recorded from the Philippines not included in the above key is *D. anthracia* Walker. The original description of this species is so inadequate that the species cannot be placed. The size and color of the antennæ would separate Walker's species from the larger forms here described. The original description of Walker's species is as follows:

Dirhinus anthracia Walker.

Dirhinus anthracia WALKER, List Hym. Brit. Mus., pt. 1 (1846) 8, 85.

Nigra, pedibus rufis, metapedibus nigris, alis limpidis.

Body black, dull, punctured: antennæ black: head clothed beneath with silvery down: tips of the scutellum dentate: abdomen smooth, shining, much shorter than the thorax: legs red; hind legs black: wings limpid; squamulæ and nervures piceous. Length of the body 2 lines; expansion of the wings 2½ lines.

Philippine Islands.

Dirhinus banksi sp. nov.

Female.—Length, 2.5 millimeters. Head above and pronotum coarsely and closely punctured; antenna as in fig. 1, *d;* posterior orbits with large umbilicate punctures; anterior part of scutum shining, but finely reticulate; sides and posterior portion of scutum coarsely punctured with a tendency to striate punctations medianly; scutellum with large punctures except for a large, polished area medianly; propodeum reticulate and with a broad, shallow depression at basal middle; first tergite with four strong longitudinal carinæ; base of second tergite striate medianly; rest of abdomen polished; hind coxæ transversely striate. Black; four anterior tibiæ and femora somewhat marked with piceous; all tarsi yellowish; wings hyaline, venation pale brownish.

Type locality.—Manila, Luzon, Philippine Islands.

Described from two specimens (one type) the sex of which I cannot be sure about, under accession No. 18576, Bureau of Science. Material collected by C. S. Banks and said to be a parasite of *Lucilia* species.

Type.—Catalogue No. 24957, United States National Museum. Left antenna of type mounted on a slide.

Named in honor of Prof. C. S. Banks.

Dirhinus luzonensis sp. nov.

Female.—Length, 4.5 millimeters. Head above with large punctures which are separated by about half their width; posterior orbits with large punctures; antenna as in fig. 1, *e;* pronotum shining, with large separate punctures; scutum shining, with large, elongate punctures at posterior middle; scutellum polished, with large punctures around sides; propodeum finely granular and with reticulations, the middle basal area depressed; first tergite short, smooth, with four rather weak, longitudinal carinæ; basal middle of second segment longitudinally striate; rest of abdomen polished; dorsal aspect of hind coxæ with transverse striæ. Black; antennæ and four anterior legs rufous; tegulæ testaceous; hind tarsi reddish yellow; wings hyaline, venation pale brown.

The paratype is somewhat smaller.

Type locality.—Manila, Luzon, Philippine Islands.

Described from two (one type) females collected by Rev. Robert Brown, S. J.

Type.—Catalogue No. 24958, United States National Museum. Right antenna of type on a slide.

Dirhinus luciliae sp. nov.

Female.—Length, 4 millimeters. Head above with large, close punctures anteriorly, punctures smaller and more widely separated posteriorly; depressed areas on vertex granular and with a few large punctures; posterior orbits with large punctures anteriorly and finely granular posteriorly; antenna as in fig. 1, *a;* pronotum with large, well-separated punctures; lateral lobes of scutum polished; median lobe of scutum finely reticulate anteriorly, posteriorly with large punctures which tend to become confluent; sides of scutellum with large punctures, the central area polished; propodeum irregularly reticulate, basal middle depressed; first tergite with four longitudinal carinæ; base of second tergite striate medianly; rest of abdomen polished; hind coxæ with transverse striæ. Black; four anterior legs rufous; flagellum, tegulæ, and hind tarsi piceous; wings hyaline, venation brown.

In the paratype the hind tarsi are yellowish brown.

Type locality.—Manila, Luzon, Philippine Islands.

Described from two (one type) females under accession No. 18575, Bureau of Science. Material collected and reared by C. S. Banks and said to be a parasite of *Lucilia* species.

Type.—Catalogue No. 24959, United States National Museum. Antenna of type and flagellum of paratype on slides.

Although the available information would suggest that this is related to *D. banksi*, the characters given in the above key should easily distinguish the two.

PERILAMPIDÆ

Genus **NESOPERILAMPUS** novum

This new genus has the general habitus of *Perilampus*, to which it runs in the available keys, but can be distinguished from the old genus by the following key:

Scrobal cavity narrow, well separated from lower margins of eyes; scape compressed; pronotum long; marginal vein much shorter than postmarginal; notauli poorly defined..... **Nesoperilampus g. nov.**

Scrobal cavity broader and not sharply defined below; scape cylindrical; pronotum short; marginal vein longer than postmarginal; notauli usually well defined..... **Perilampus Latreille.**

Antennæ inserted well above the lower margins of eyes, 13-jointed, scape compressed, one ring joint, club poorly defined and indistinctly 3-jointed; scrobal cavity narrow, pointed above, and sharply defined to lower margin; pronotum about half as long as scutum and sculptured like it; notauli poorly defined; scutellum distinctly longer than scutum, pointed posteriorly, and projecting beyond propodeum; marginal vein much shorter than postmarginal. Black.

Genotype, *Nesoperilampus typicus* sp. nov.

Nesoperilampus typicus sp. nov.

Male.—Length, 3.5 millimeters; length of anterior wing, 3 millimeters. Anterior margin of clypeus broadly, shallowly emarginate medianly; surface of clypeus rather coarsely coriaceous and clothed with long hair; at least sides of scrobal cavity finely aciculate; front (except scrobal cavity) and sides of head with strong dorsoventral rugæ; vertex with strong transverse rugæ; first funicle joint longer than second which is slightly longer than third; club indistinctly 3-jointed; pronotum, scutum, and scutellum with shallow umbilicate punctures; scutellum produced posteriorly into a rather acute triangle, the free edge of which has a broad, deep, shining furrow with the ventral lip

extending narrowly beyond the punctured portion of scutellum; posterior face of propodeum with irregular transverse striæ; mesepisternum largely smooth and shining; sides of propodeum coarsely reticulate; abdomen smooth and polished. Black; funicle, except extreme apex, rufo-ferruginous; apices of tibiæ and all tarsi yellowish; wings hyaline, venation pale brown; hair of head and thorax gray.

Type locality.—Kolambugan, Mindanao, Philippine Islands. Described from one male collected in 1914 by C. S. Banks.

Type.—Catalogue No. 24973, United States National Museum.

Genus PERILAMPUS Latreille

Key to certain Oriental species of Perilampus.

1. Base of abdomen opaque, covered with small punctures..... 2.
   Abdomen entirely smooth and shining..... 4.
2. Bright green; area laterad of notauli striate..... **P. singaporensis sp. nov.**
   Dark green or greenish black..... 3.
3. Area laterad of notauli smooth; scutellum distinctly triangular posteriorly and emarginate..... **P. orientalis sp. nov.**
   Area laterad of notauli sculptured; scutellum obtusely subtriangular posteriorly and not emarginate..... **P. punctiventris Crawford.**
4. Dark green; posterior orbits with strong striæ except for a narrow area close to eye..... **P. luzonensis Crawford.**
   Black; posterior orbits except a narrow posterior margin smooth. **P. nesiotes Crawford.**

Perilampus singaporensis sp. nov.

The bright green color separates this species from the other Oriental forms.

Female.—Length, 4 millimeters. Clypeus gently convex, shining, smooth except for a few setigerous punctures, the anterior margin depressed and slightly, broadly, arcuately emarginate; malar furrow distinct; carina defining scrobal cavity dorsally extending ventrally to a point opposite the insertion of antennæ; scrobal cavity sharply angulate dorsally and terminating immediately behind anterior ocellus; area below lateral ocelli with a few raised lines; posterior part of vertex with a few transverse rugæ; posterior orbits smooth, shining except posteriorly where there are a few dorsoventral striæ; funicle wanting; pronotum, scutum (except as mentioned below), and scutellum with large umbilicate punctures; notauli foveolate; area just lateral to notauli shining and with oblique striations; posterior margin of pronotum narrowly truncate, the edge gently upturned and slightly emarginate; posterior face of propodeum

shining, with a median ridge bounded by a rather broad depressed area; base of abdomen subopaque, with fine close punctures. Bright green (including legs to base of tarsi); tarsi ferruginous; wings hyaline, venation brown.

Type locality.—Singapore, Straits Settlements.

Described from a single female received from C. F. Baker.

Type.—Catalogue No. 24974, United States National Museum.

Perilampus orientalis sp. nov.

This species seems to be allied to *Perilampus megalaspis* Cameron but differs in the lack of striæ on the malar space, the absence of white hair on the head, etc.

Female.—Length, 3.75 millimeters. Clypeus gently convex, shining, with a few setigerous punctures, the anterior margin gently rounded out, not depressed; malar furrow distinct; scrobal cavity limited dorsally by a short carina (extending a short distance below ocelli), the rest of the area dorsad of the depression with short striæ which extend ventrally nearly to a point opposite the insertion of antennæ; these striæ do not reach the inner eye margins; lateral areas of frons and vertex shining, without definite sculpture; posterior orbits shining and without sculpture except for a few striæ posteriorly; flagellum stout, first funicle joint a little longer than second; pronotum with three rows of umbilicate punctures; scutum (except as mentioned below) and scutellum with umbilicate punctures; notauli not sharply defined; the area just lateral to notauli shining and without sculpture; scutellum narrow posteriorly and distinctly emarginate; posterior face of propodeum shining, with a median ridge bounded laterally by a foveolate depressed area; base of abdomen subopaque with close, fine punctures. Head and thorax dark metallic green, abdomen blue-black; anterior tarsi pale, other tarsi wanting; wings hyaline, venation pale brown.

Type locality.—Singapore, Straits Settlements.

Described from one female received from C. F. Baker.

Type.—Catalogue No. 24975, United States National Museum.

Perilampus nesiotes Crawford.

A single female from Ilocos Norte, Luzon, collected June 2, 1912, by C. S. Banks and bearing the word "Bangui" on the label agrees very closely with the unique type of the Sumatran species *P. nesiotes* Crawford. The Luzon specimen is a trifle larger, but I see no characters by which it can be separated from the type.

BRACONIDÆ

Bassus cylasovorus sp. nov.

Wings dusky; head, prothorax, and scutum largely rufous; sides of thorax, propodeum, and abdomen largely black.

Female.—Length, 4 millimeters. Head seen from in front but little wider than high; malar space somewhat shorter than the greatest transverse diameter of eye; clypeus truncate apically, convex toward median line; posterior orbits narrow; occiput concave; postocellar line slightly shorter than ocellocular line; head smooth, shining, with only setigerous punctures; antenna longer than head and thorax, 31-jointed; thorax shining; suture before scutellum broad, coarsely granular; propodeum smooth, the central dorsal area coarsely punctate-reticulate, the laterodorsal area punctate; abdomen shining, highly polished; ovipositor slightly longer than abdomen; stigma broad, about 4.5 times as long as broad; radial cell very narrow, the radius curved anteriorly. Black; head except spot surrounding ocelli and reaching bases of antennæ, prothorax, and scutum except a central spot rufous; apical margin of first tergite, base of second, and first two sternites yellowish; four anterior legs reddish yellow; hind legs black except basal three-fourths of tibiæ which are whitish; wings dusky hyaline, venation dark brown.

Male.—Length, 4 millimeters. Besides the usual sexual characters the male differs from the female only as follows: Head and scutum entirely rufous; second and third tergites except a median spot yellowish.

Type locality.—Manila, Philippine Islands.

Described from one female (type) and one male received from C. S. Banks and said to be parasitic on *Cylas turcipennis* Boh. The labels bear the date April 20, 1919, and "A. G. Toquero. L. H. R. 495 Bur. Agr., P. I."

Type.—Catalogue No. 24730, United States National Museum.

Microbracon cylasovorus sp. nov.

Female.—Length, 2.5 millimeters. Head strongly receding behind eyes, polished; ocelli in an equilateral triangle; antennæ almost as long as body, flagellar joints of nearly equal length; prescutum completely defined; notauli not foveolate; mesonotum shining, polished, with rather long sparse hair; posterior part of scutum and anterior part of scutellum with distinct separate punctures; propodeum polished but with a median longitudinal area which is sculptured; sides of first tergite coarsely reticu-

late, the central portion polished; second tergite longitudinally striate-punctate and with an elongate triangular raised and polished area at basal middle; suture between second and third tergites coarsely foveolate; third, fourth, and base of fifth tergites longitudinally striate-punctate, remaining tergites polished; ovipositor extending beyond abdomen a distance subequal with abdomen beyond first tergite; first abscissa of radius subequal with first abscissa of stigma; second abscissa of radius subequal with second abscissa of stigma. Rufous; spot around ocelli, three spots on scutum, propodeum and abdomen piceous; legs reddish yellow; wings hyaline, venation pale brown.

In one paratype the abdomen is almost entirely rufous.

Type locality.—Manila, Philippine Islands.

Described from three females (one type) received from C. S. Banks and said to have been reared from *Cylas turcipennis* Boh. Specimens labeled as collected February 14, 1919, by A. G. Toquero and given No. "L. H. R. 481."

Type.—Catalogue No. 24731, United States National Museum.

Paratype.—Returned to Bureau of Science, Manila.

ILLUSTRATION

[Drawings made by Eleanora Armstrong from slides prepared by S. A. Rohwer.]

TEXT FIGURE

FIG. 1. Antennæ of *Dirhinus* and *Eniaca; a, Dirhinus luciliae* sp. nov. (type); *b, D. excavatus* Dalman (det. Ashmead); *c, Eniaca hesperidumi* Rossi; *d, D. banksi* sp. nov. (type); *e, D. luzonensis* sp. nov. (type); *f, D. auratus* Ashmead, male (det. Ashmead).

PHILIPPINE SPECIES OF THE GENUS PROTHYMA AND OTHER CICINDELINÆ

By WALTHER HORN

Of Berlin-Dahlem, Germany

It has not been possible until recently to obtain a correct idea of the specific values of the various species of *Prothyma* from the Philippine Islands, owing to the fact that the material collected was far too scant. Localities given by Cuming, Semper, and others have but little value. Collecting by Whitehead, Everett, Doherty, Banks, Baker, and Schultze has resulted in obtaining material with exact localities and, consequently, the specific features have begun to clear up.

At various times I have received material from European dealers in insects. Such material is usually not very valuable, as one can place little confidence in the localities mentioned by them.

The result of the study of these collections is that we note a most extraordinary degree of variability within the several species. This makes them still more difficult to study, as the number of characters used for diagnosis has always been very small. Herewith I give a résumé of these characters and the variations that may occur.

Prothyma hopkinsi Horn.

Labrum with the brownish sagittal stripe sometimes well developed, sometimes lacking. The portion bearing the three middle teeth sometimes long and narrow, sometimes short and broad; sagittal tooth of variable length, first segment of antennæ entirely yellow or almost entirely dark metallic, but its dorsal surface frequently dark, its ventral surface distad usually yellow. The frons and vertex are usually metallic coppery, with the antennæ, ocular region, portions of the orbit, and disk of vertex frequently greenish. The pronotum may be longer or shorter, its middle portion usually cylindrical or converging caudad. Dorsal surface moderately or strongly convex, but sometimes quite plane (especially on the caudal half); its sculpture fine

or coarse. Some specimens show the pronotum short, roughly sculptured, the sides convergent, and the dorsum flattened caudad. Others show the pronotum longer, cylindrical, finely transversely striated, and strongly convex. The pronotum is usually copper colored, the transverse sulci being bluish or greenish laterad and the lateral borders broadly or narrowly blue. Sometimes the whole cephalic margin of the pronotum is greenish or there is a greenish golden sheen mediad with blue lateral borders cephalad of the posterior margin and caudad of the bluish anterior sulcus. Some specimens show the transverse sulci to be green or golden, some almost entirely copper colored. The elytra may be long or short, the sculpture being sometimes shallow and less confluent in the caudal half; the apical borders have a narrow bluish or greenish stripe, the lateral borders a larger one of dark copper violet, mediad of which on the anterior fifth is a greenish or bluish stripe (which may be entirely obsolete, or may extend caudad to yellow discal patch, or take the form of a diffuse golden stripe near the disk). Occasionally the lateral borders are bluish violet with a green stripe mediad in the first fifth; the lateral borders are sometimes brownish coppery, being lighter near the humeral angle, or the border may differ from the disk only by a more decidedly copper violet hue. The humeral macula is sometimes lacking in the female. The distal spot is short triangular, horizontal or longer or narrower, having an oblique direction toward the disk. Its inner half may be narrowed or equal to the outer. The apical spot may be broad or narrow, sometimes circular, sometimes transversely oval, and not infrequently with its posterior margin concave. All the spots may be white.

LUZON, Laguna Province, Mount Maquiling, Mount Banahao, and Paete: Tayabas Province, Dolores: Bataan Province, Mount Limay.

There are two subspecies of *Prothyma hopkinsi.*

Prothyma hopkinsi subsp. bakeri Horn.

This subspecies was originally described as a true species. At first view the fine blue color of the frons, vertex, pronotum, and bases of the elytra, the very convex, rather globose middle portion of the pronotum, the short and on their caudal half less deeply and densely sculptured elytra seem to be quite characteristic, but intermediate forms occur; for example, a specimen from Polillo Island having exactly the same shape and sculpture

as *bakeri,* but with most of the frons, vertex, and pronotal disk coppery. The disk of the elytron in this specimen shows a color intermediate between the forms already described. The blue of the bases of the elytra is very variable (sometimes the base and the lateral areas in the anterior two-fifths are blue; occasionally there is only a broad blue stripe surrounding the whitish humeral macula (all maculæ are whitish in *bakeri*) and extending caudad toward the disk, terminating before the median spot; sometimes the blue has the same distribution as in typical *P. hopkinsi.*

LUZON, Tayabas Province, Malinao.

Prothyma hopkinsi subsp. rotundato-cuprescens subsp. nov.

Differt a forma prioritatis sagitalli labri parte infuscata; tota corporis superficie laetius aureo-cuprascente; elytris subnitentibus; capita pronotoque valde splendentibus; pronoto sat convexo; elytrorum maculis testaceis, paullo majoribus; media lata obliqua, multo breviore; ante-apicali plus minusve rotundata; primo antennarum articulo testaceo.

Long 11–12 mm. (sine labro).

Insula Biliran (*McGregor*) a Dom W. Schultze mihi comunicata; ♂ in collectione mea, ♀ in collectione W. Schultze.

The dorsal surface is golden coppery; head and pronotum very brilliant, elytra a little duller, with larger but shorter yellow spots; pronotal sulci greenish blue in their depths. Lateral border of pronotum narrowly greenish or bluish. Borders of elytra dark copper violet, on the first fifth with a greenish or bluish submarginal stripe.

Prothyma lucidicollis Chaud.

The typical *P. lucidicollis* has a strongly globose pronotum, very convex dorsad; rather convex elytra, with moderately confluent sculpture. Frontovertical area and pronotum golden coppery, very brilliant, with fine sculpture intermittently obsolete. *Prothyma heteromallicollis* Horn, described originally as a species, is but a subspecies of *P. lucidicollis,* although the typical form differs as follows: Middle portion of pronotum cylindrical, plane dorsad; elytra less convex, with deep sculpture and with strongly confluent punctures. Dorsal area of frons, vertex, and pronotum dull and densely finely sculptured.

Both of these typical forms are from unrecorded localities in the Philippine Islands.

I have recently received material from Iligan, Agusan, Butuan, and Surigao, Mindanao, and from Biliran Island that shows a variability almost as striking as is shown by *Prothyma hopkinsi*, but all these specimens are mere intermediate forms between the type and my subspecies that may be characterized as follows: Head often bulky and with the occipital portion dull, densely but finely sculptured, dark coppery or lighter cuprescent, with or without greenish blue reflections here and there and with the lateral margin of the vertex broadly greenish or bluish. Pronotum more or less convex, sometimes slightly globose, densely but finely sculptured, semiopaque or brilliantly dark coppery, with a narrow, greenish stripe near the lateral margins; transverse sulci coppery or greenish, occasionally with the whole surface, except the central disk, more or less bluish or greenish and with the four borders broadly greenish. Elytra with a short greenish stripe extending from the humeral angle halfway to the median spot entad of the dark purple-violet margin, which may be lacking. Sculpture of the distal half more or less confluent but never deeply crenulated. Spots yellowish or whitish; middle one sometimes longer or narrower, directed obliquely caudad; anteapical spot frequently slightly prolongated in the direction of the sutural spine.

Subspecies *coerulea* Horn differs from the typical subspecies *heteromallicollis* by being narrower and more elongated, the middle portion of the pronotum being long, parallel sided, plane dorsad, with fine, dense, transverse striations. Segments 2 to 4 of the antennæ almost entirely, tibiæ often, yellow; sculpture of elytra denser, deeper, and more confluent. Middle spot of elytra smaller than anteapical one. Dorsal surface more or less blue.

Prothyma banksi sp. nov.

Species quasdam generis Odontochilae simulans. Fronte interoculos evidenter excavata ibique impressione discoidali in forma "vestigii equi" (postice conclusi) ornata. Elytris impressionibus 5 indistinctis ornatis: 1ª pone humeros oblique suturam versus directa, 2ª longitudinali sat longa in disco laterali juxta maculam median, 3ª parva juxta maculam ante-apicalem, 4ª parva sed profundiore in angulo suturali, 5ª longa indistincta levissima juxta suturam posita; dimidia parte postica elytrorum longe et dense (praesertim transversaliter) plicata: rugis valde distinctis.

Long. 14–15 mm. (sine labro).

Insula Panay, Antique, Culasi (*McGregor*) a Dom W. Schultze mihi data: 1 ♀ in collectione mea, 1 ♀ in collectione W. Schultze.

This species differs from *Prothyma hopkinsi* by being larger; labrum dark with an irregular, yellow disk; frons between the eyes with a large central impression; pronotum cylindrical, only slightly convex, densely transversely striate. Elytra slightly more flattened, uneven, with the impressions as described above; more roughly and deeply sculptured throughout. Sculpture crenulate-confluent on apical half (except near the lateral margins where the individual punctures are separated and not deep). The individual crenulations sometimes occupy three-fourths of the width of the elytron; the whole dorsal surface is of a dull, dark brown coppery bronze. Sides of vertex and pronotum bluish green; lateral borders of elytra dark purple-violet, with a short greenish blue submarginal stripe in the basal fourth mediad of the marginal color. There are two or three pale yellow spots on each elytron; a small humeral dot, sometimes lacking, a short oblique middle patch extending to disk and becoming slightly more remote from margin than in *P. hopkinsi*.

Many years ago Prof. Charles S. Banks sent me a male, 13 millimeters in length, of a new *Prothyma*, from the Bureau of Science collection, Mount Canlaon, Negros (800 meters), for study and I have dedicated this new species to him.

The penis of this specimen has, according to my notes, a "plain bulky apex."

Philippine species of the genus Prothyma.

1. Labrum metallic. Small species (8.5 to 9.5 millimeters exclusive of labrum); apex of penis moderately tapering with the tip (turned toward concave side) showing a very short hook directed to concave (left) side. Tibiæ often more or less yellow ..... 2.
   Labrum yellow or yellow and dark; a larger species (10.5 to 14 millimeters); apex of penis variable in length. Tip never showing a hook or angle directed toward the concave (left) side. Tibiæ dark metallic ..... 4.
2. Dorsum of head and pronotum very brilliant, the sculpture very fine or obsolescent. Pronotum very convex ..... P. lucidicollis Chaud.
   Dorsum of head and pronotum not brilliant; their sculpture fine and dense. Pronotum less convex or even plane ..... 3.
3. Pronotum and elytra short. Dorsal surface coppery, with green reflections caudad of humeral angles. Middle spot of elytra not smaller than the anteapical one .... P. lucidicollis subsp. heteromallicollis Horn.
   Pronotum and elytra more elongate. Dorsal surface entirely or at least its greater portion blue. Segments 2 to 4 of antennæ often yellow.

Middle spot of elytra smaller than anteapical one. Sculpture of elytra dense, deep, and generally confluent.

P. lucidicollis subsp. **coerulea** Horn.

4. Frons with a deep horseshoe-shaped sulcus between eyes, in center of disk; first four segments of antennæ metallic black. Elytra with undulated surface, each with longitudinal basal impressions.

P. banksi sp. nov.

Frons without horseshoe-shaped discal impression and sulcus; first or third segment of antennæ often more or less yellow or pale brown. Elytra without longitudinal impressions..... 5.

5. First segment of antennæ almost entirely dark metallic. Dorsal surface of third segment almost entirely brownish. Middle portion of pronotum long cylindrical. Lateral half of base of elytra with isolated punctures (not confluent), interstices larger than punctures themselves. Penis with long narrow apex, the tip of which shows a small flattened prolongation on its convex (right) side.

P. schultzei Horn.

First segment of antennæ usually more or less yellow. Dorsal surface of third segment dark metallic, except sometimes at apex. Middle portion of pronotum variable. Basal half of elytra densely intricately punctured. Punctures often slightly confluent. Penis with a very short, bulky, conical apex, the tip of which shows a slight trace of a rectangular prolongation directed toward the convex (right) side.... 6.

6. Middle portion of pronotum variably convex. The whole of the dorsum of the body brownish coppery. Frons, vertex, and pronotum moderately brilliant. Sculpture of the apical half of the elytra dense and slightly confluent. Middle spot of elytra elongate... **P. hopkinsi** Horn.

Middle portion of pronotum rather convex, entire dorsum of body brownish coppery; frons, vertex, and pronotum brilliant; sculpture of apical half of elytra dense and confluent, two posterior spots of elytra yellowish and irregularly rounded.

P. hopkinsi subsp. **rotundato-cuprescens** subsp. nov.

Middle portion of pronotum convex. Dorsum of frons, vertex, and pronotum blue or at least greenish blue coppery. Sculpture of apical half of elytra less dense and only slightly confluent. Middle and posterior spot of elytra whitish and elongate.

P. hopkinsi subsp. **bakeri** Horn.

Among the Cicindelinæ collected by Mr. W. Schultze, of Manila, are to be found a great many very interesting species. They are as follows:

Collyris speciosa Chaud. Mindoro, near Abra de Ilog.

Collyris similior W. Horn. Mindanao, Momungan, and Zamboanga.

Collyris chaudoiri W. Horn. Biliran Island. Punctures on the basal and apical thirds of elytra less dense and of smaller size than usual.

Collyris emarginata. Mindanao, Zamboanga.

Collyris albitarsis.

Tricondyla aptera subsp. *globicollis.* Polillo Island; Mindanao, near Surigao.

Tricondyla cyanipes subsp. *conicicollis* Chaud. Panay, Capiz; Dinagat Islands.

Tricondyla subsp. *elongata* W. Horn. Mindanao, Lanao Province near Iligan.
Tricondyla subsp. *brunnipes* Motsch. Luzon, Benguet Subprovince, Baguio.
Therates fasciatus subsp. *flavilabris* F. Leyte, Tacloban; Samar, Catbalogan; Mindanao.
Eurytarsa beccarii Gestro. Luzon, Benguet Subprovince, Mount Santo Tomas (2,400 meters).
Heptodonta melanopyga Schm. Mindanao, Surigao.
Cicindela virginalis W. Horn. Panay, Antique Province, Culasi.
Cicindela conicollis Schm. Luzon, Benguet Subprovince, near Baguio.
Cicindela mandibularis Schm. Luzon, Laguna Province, near Paete.
Cicindela conspicua Schm. Luzon, Kalinga Subprovince, near Balbalin.
Cicindela fugax Schm. Mindanao, Surigao.
Cicindela clara subsp. *rugothoracica* W. Horn. Luzon, Benguet Subprovince, Pauai (Haight's).
Cicindela excisa Schm. Panay, Capiz Province, Libacao.
Cicindela chlorochila F. Biliran Island.

The species of *Collyris* fly in full sunshine, appearing like small wasps, settling for a short time on leaves and stems of plants where they run about rapidly and again fly away. The species of *Tricondyla* usually run up the bases of tree trunks to the distance of about a meter. Species of the genus *Eurytarsa* are usually found in numbers running around on mossy stones. *Therates fasciatus* may be taken in the half shadows of forests, flying from leaf to leaf. They give off a very pleasant aromatic odor when captured. All the known species of *Prothyma* fly very rapidly at a height of about a meter in the half shadows of damp forests with much undergrowth; here they alight on the leaves. *Cicindela clara* subsp. *rugothoracica* runs and flies rapidly near damp places along roadsides.

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A FEEDING EXPERIMENT ON TWO HUNDRED LEPERS AT CULION LEPER COLONY, PHILIPPINE ISLANDS

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ONE PLATE

At the request of Governor-General Leonard Wood and Dr. Vicente de Jesus, I organized and conducted a feeding experiment on two hundred lepers at Culion Leper Colony, Philippine Islands.

This feeding work was undertaken for the following reasons: (*a*) The chaulmoogra ethyl ester treatment for leprosy in many respects is not successful with lepers who have syphilis, yaws, or tuberculosis; many of the Culion lepers are tuberculous; (*b*) the Government raw rations now supplied to more than 4,000 lepers at Culion are decidedly insufficient in calorific value, mineral matter, vitamine content, and quantity of protein; (*c*) even the supplies that are given out at Culion are issued in irregular amounts and often at irregular intervals, particularly in the case of fish and vegetables.

The last condition is due largely to the following factors: Culion Leper Colony is located on the rocky coast of an island about 200 miles (320 kilometers) south of Manila. Very little gardening is done by the lepers. The arrival of boats in the past has been irregular, and there is a lack of proper refrigeration in the colony, so that supplies cannot be stored for long periods of time.

The regular Culion diet, as indicated by a table given me by the steward of the colony, follows:

Culion Leper Colony, September 19, 1921.

Standard weekly ration furnished each leper as per last record on file.

6 ounces beef, fresh.
1 loaf bread.
1 kilogram camotes, when available.
0.2 package chocolate (for hospital).
0.75 chupa[1] coffee, green.
1.5 kilograms fish, fresh (0.25 kilogram daily for six days).

[1] A chupa is approximately 200 grams.

0.1 pound lard compound.
0.5 head onion.
14.5 chupas rice, unpolished.
0.75 chupa salt, native.
0.75 chupa sugar, brown.
Vegetables and fresh fruits when available.

The above issues represent an average per capita issued for general ration. Chocolate, etc., are issued monthly, and milk is consumed in hospitals and by young children. This standard ration might be altered by actual circumstances and substituted by the equivalent amount of other food, whenever available, and at the discretion of the chief of the colony. As a matter of fact, the fish supply last year was so irregular that a daily average of only about 100 grams per person was given to between 4,000 and 5,000 lepers.

I have been unable to find any records in medical literature of previous feeding work done in leprosy cases, so that the plan of the diets was based on the following theories:

Since there is a leprotic fever in connection with the disease, also phthisis, and since in all fevers the metabolic processes are increased while at the same time the power of assimilation is diminished, and there is a burning up of body proteins as well as fats, I decided in favor of a high-calorie diet.

Honeij has shown that there is a definite absorption of bone salts in leprosy, and experimental work indicates that in leprosy the organism exhibits a tendency to retain calcium and magnesium, whether the patient is maintained upon a diet containing little or much of these elements; the more advanced the pathological condition, the more evident does this tendency to retention become.

It is therefore conceivable that under dietary conditions in which calcium is not particularly abundant, the lack of this element may play a material part in the rapidity of the progress of disease.(1)

In view of this work, and the recent work on experimental rickets, which shows the remarkable influence of certain substances present in cod-liver oil and also in green vegetables in stimulating the deposition of calcium, I decided in favor of an adequate supply of fresh vegetables and fruits. These would serve the additional purpose of increasing the amount of vitamines and of mineral matter.(2, 3)

To supplement the insufficient fish ration with a cheap available protein, I suggested the use of mungo, *Phaseolus aureus* Roxburgh, a bean which is abundant in the Islands. Previous

analysis and experimental feeding with this bean showed that it contains about 22 per cent of protein, which is of fairly good quality.(4)

The ration shown in Table 1 was worked out as a basal diet, which could be modified as needed.

TABLE 1.—*Daily basal ration, subject to modification, for an adult leper.*

	Protein.	Fat.	Carbohydrate.	Calories.
	g.	*g.*	*g.*	
Unpolished rice, 2 chupas, 400 grams	32	1.2	316.0	1,436
Mungo, 1.5 chupas, 300 grams	66	2.4	176.4	993
Salted pork or fat, 20 grams	----	20.0	----	178
Sugar, 25 grams	----	----	25.0	100
Fresh native vegetables (from 300 to 400 grams), such as camote, upo, mungo-bean sprout, pechay, camote leaves, gabi, squash, tomato, ube, eggplant, patola, onion, etc., or fruits such as papaya, orange, banana, coconut, etc.	----	----	----	[a]100
Total	98	23.6	517.4	[b]2,807

[a] The calorific value of this item will be from 60 to 300 calories, according to the vegetables or fruits selected.

[b] Approximately.

Children from 8 to 12 years of age were to be given seven-tenths of the amounts prescribed, and in addition one glass of milk a day. Three hundred grams of fish or meat can be substituted for the mungo, but with such substitution the rice ration or the vegetable ration should be increased from 400 to 500 grams. This increase is recommended because neither fish nor lean meat has the calorific value of the mungo bean.

The feeding experiment was conducted only on leper volunteers. In making a choice of applicants the following rules were adhered to in each case: (*a*) Representatives were selected from each province of the Islands; (*b*) lepers were selected in whom the disease was at the medium stage of advancement; (*c*) when all other conditions were the same preference was given to lepers who in the past had depended largely on Government rations. It was believed that this procedure would give a more-striking comparison as to the relative values of the old and the new diets. The applicants pledged themselves to take no food on the outside, but otherwise their regular medical treatment and their usual occupations and habits of living were not altered in any way.

The theater was converted into a large dining room, a card system of entrance was used, and the attendance at each meal was recorded. The weights of the lepers were taken each week.

An open-air kitchen was erected by the side of the theater; several lepers were chosen to assist in preparing the food, and the cooking was done in plain view of the entire colony.

The meals were made as nearly equal from the standpoint of calories as possible. The hours of 7, 12, and 5.30 were chosen for meals.

Table 2 shows the composition of eighteen typical meals, illustrative of the type of food given. Table 3 records the weights of the lepers. Calculation of the calorific value of all of the menus shows an average of 3,145 calories per adult per day, and an average of 2,673 calories per child per day. However, it cannot be asserted that each of the lepers ate the above number of calories per day, since there were no facilities for weighing the food which remained, and the appetites of the lepers naturally were somewhat variable. On the whole, however, their interest in their food was surprisingly constant, and they consumed the larger number of calories without any inconvenience and were apparently improved in energy and spirits.

The average cost, calculated on the prices of the first forty-five meals, was 31 centavos per person per day if milk and coffee are excluded from the calculation, and 35 centavos per day if these items are included. This cost can be greatly reduced without affecting the dietary value of the food, by careful study of the market prices, and selection of the cheaper varieties of proteins, beans, press cakes, vegetables, and fruits.

The main object in this early experimental work was to demonstrate the physiological effects of a better-balanced diet. It was necessary to keep constantly in mind the fact that all the people experimented on were volunteers, sick, and naturally suspicious of any radical innovation.

SUMMARY

This experiment lasted from January 20 to February 24, 1922; of the 200 persons included, 164, or 82 per cent, gained from 100 grams to 5.1 kilograms in weight with an average increase of 2.5 kilograms per person.

Only 14.5 per cent of the patients decreased in weight, with an average decrease of 1.3 kilograms per person; 3.5 per cent remained stationary.

The increase was more frequent in patients under 50 years of age and was almost negligible in patients over 50 years of age.

Lepers in the incipient stage of the disease are more prone to variations. Of the 54 cases composing the incipient group, 90.7 per cent increased in weight, and none remained stationary.

Of the 101 cases forming the middle group, 83.1 per cent gained in weight, and 11.8 per cent lost weight. Of the 45 advanced cases, 68.8 per cent gained weight, and 26.6 per cent lost weight.

While this experiment was not conducted on a rigidly scientific basis, due to lack of proper laboratory facilities, the conclusion seems justified, from the above results, that a high-calorie diet, with an adequate supply of mineral matter, of vitamines, and of that substance found in green vegetables which aids in the deposition of calcium is beneficial to lepers and that their weight and general health are improved thereby.

ACKNOWLEDGMENT

I am deeply indebted to Dr. Jose Avellana, of Culion Leper Colony, for his help in completing the records given below, also to Dr. Vicente de Jesus and Dr. M. Griffin for valuable coöperation.

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TABLE 2.—*Six days' menus, illustrative of the kind and quantity of food given in the experimental feeding of two hundred lepers at Culion Leper Colony, January 21 to 26, 1922.*

JANUARY 21, 1922.						
Food.	Weight.	Protein.	Fat.	Carbohydrate.	Fuel value.	Cost.
Morning.	*Kilos.*	*g.*	*g.*	*g.*	*Calories.*	*Pesos.*
Fish	9.25	1,730	120	101.8	8,232	2.78
Mungo	9.25	2,044.3	74	5,439	30,618	1.76
Pechay	9.5	125	42.5	580	3,287.5	2.50
Eggplant	12.5	133.7	56.2	767.5	5,462.5	5.00
Pork	0.5	9.5	431	----------	4,045	0.50
Onion	0.5	8	1.5	49.5	245	0.08
Sugar	2	----------	----------	2,000	8,000	0.30
Rice	35	2,800	105	27,650	125,650	4.20
		6,850.5	830.2	36,587.8	185,540	16.92
Milk, 25 cans, small size, for children only	----------	363	440	605	7,850	8.75
Coffee	1.5	----------	----------	----------	----------	0.85
		7,213.5	1,270.2	37,192.8	193,390	26.52

TABLE 2.—*Six days' menus, illustrative of the kind and quantity of food given in the experimental feeding of two hundred lepers at Culion Leper Colony, January 21 to 26, 1922*—Continued.

Food.	Weight.	Protein.	Fat.	Carbohydrate.	Fuel value.	Cost.
JANUARY 21, 1922.						
Noon.	*Kilos.*	*g.*	*g.*	*g.*	*Calories.*	*Pesos.*
Mungo	9.25	2,044.3	74	5,439	30,618	1.56
Pechay	14	140	47.6	649.6	3,682	2.80
Eggplant	14	149.8	63	859.6	6,118	5.60
Onion	1	16	3	99	490	0.16
Pork	0.5	9.5	431	----------	4,045	0.50
Lard	1.5	52.5	1,320	----------	12,510	3.38
Rice	35	2,800	105	27,650	125,650	4.20
		6,212.1	2,043.6	34,697.2	183,113	18.20
Night.						
Meat	25	4,750	4,775	----------	63,750	18.50
Green papaya	7	76.3	11.9	259	1,484	1.40
Onion	2	32	6	198	980	0.32
Green pepper	2	----------	----------	----------	----------	0.40
Tomato, 2 cans	----------	24	4	80	460	0.31
Ripe papaya	13	141.7	22.1	481	2,756	2.60
Rice	35	2,800	105	27,650	125,650	4.20
		7,824	4,924	28,668	195,080	27.73
JANUARY 22, 1922.						
Morning.						
Fish	20	3,740	260	220	17,800	6.00
Onion	1	16	3	99	490	0.16
Pepper	1	----------	----------	----------	----------	0.20
Patola	28	176.4	36.4	1,190	5,936	11.20
Rice	35	2,800	105	27,650	125,650	4.20
Sugar	2	----------	----------	2,000	8,000	0.30
		6,732.4	404.4	31,159	157,876	22.06
Milk, 50 glasses, 25 small cans, for children only	----------	363	440	605	7,850	8.75
Coffee	1.5	----------	----------	----------	----------	0.85
		7,095.4	844.4	31,764	165,726	31.66
Noon.						
Beef	20	3,800	3,820	----------	51,000	14.80
Tomato, 2 cans	----------	24	4	80	460	0.31
Onion	2	32	6	198	980	0.32
Pork	0.5	9.5	431	----------	4,045	0.50
Papaya	5	54.5	8.5	185	1,060	1.00
Eggplant	28	299.6	126	1,719.2	12,236	11.20
Lard	2	70	1,760	----------	16,680	4.50
Rice	35	2,800	105	27,650	125,650	4.20
		7,089.6	6,260.5	29,832.2	212,111	36.83

TABLE 2.—*Six days' menus, illustrative of the kind and quantity of food given in the experimental feeding of two hundred lepers at Culion Leper Colony, January 21 to 26, 1922*—Continued.

Food.	Weight.	Protein.	Fat.	Carbohydrate.	Fuel value.	Cost.
JANUARY 22, 1922.						
Night.	*Kilos.*	*g.*	*g.*	*g.*	*Calories.*	*Pesos.*
Mungo	9.25	2,044.3	74	5,439	30,618	1.56
Fish	9.25	1,730	120	101.8	8,232	2.78
Green pepper	2					0.40
Onion	2	32	6	198	980	0.32
Lard	2	70	1,760		16,680	4.50
Pechay	28	280	95.2	1,299.2	7,364	5.60
Rice	35	2,800	105	27,650	125,650	4.20
		6,956.3	2,160.2	34,688	189,524	19.36
JANUARY 23, 1922.						
Morning.						
Fish	20	3,740	260	220	17,800	6.00
Onion	2	32	6	198	980	0.32
Green pepper	0.5					0.10
Lard	2	70	1,760		16,680	4.50
Rice	35	2,800	105	27,650	125,650	4.20
Sugar	4			4,000	16,000	0.60
Coffee	1.5					0.85
		6,642	2,131	32,068	177,110	16.57
Milk, 25 cans, for children only		363	440	605	7,850	8.75
		7,005	2,571	32,673	184,960	25.32
Noon.						
Banana	25	325	150	5,500	25,250	5.50
Lard	2	70	1,760		16,680	4.50
Sugar	1			1,000	4,000	0.15
Rice	35	2,800	105	27,650	125,650	4.20
		3,195	2,015	34,150	171,580	14.35
Night.						
Salmon	18	3,924	2,178		36,180	5.40
Onion	1.5	24	4.5	148.5	735	0.24
Lard	0.5	17.5	440		4,170	1.13
Patola	12.5	78.75	16.25	531.25	2,650	5.00
Eggplant	12.5	133.75	56.25	767.5	5,462.5	5.00
Rice	35	2,800	105	27,650	125,650	4.20
		6,978	2,800	29,097.25	174,847.5	20.97
JANUARY 24, 1922.						
Morning.						
Fish	12	2,244	156	132	10,680	3.60
Upo	20	100	18	668	3,320	3.20
Onion	1	16	3	99	490	0.16
Green pepper	1					0.20
Corn	35	3,220	665	26,390	127,750	5.25
		5,580	842	27,289	142,240	12.41

TABLE 2.—*Six days' menus, illustrative of the kind and quantity of food given in the experimental feeding of two hundred lepers at Culion Leper Colony, January 21 to 26, 1922*—Continued.

Food.	Weight.	Protein.	Fat.	Carbohydrate.	Fuel value.	Cost.
JANUARY 24, 1922.						
Noon.	*Kilos.*	*g.*	*g.*	*g.*	*Calories.*	*Pesos.*
Mungo	18.5	4,088.5	148	10,878	61,235	8.13
Pork	1	19	862	----	8,090	1.00
Pepper	0.5	----	----	----	----	0.10
Onion	1	16	3	99	490	0.16
Pechay	2	20	6.8	92.8	526	0.40
Eggplant	2	21.4	9	122.8	874	0.80
Papaya	18	196.2	30.6	666	3,816	3.60
Sugar	1	----	----	1,000	4,000	0.15
Rice	35	2,800	105	27,650	125,650	4.20
		7,161.1	1,164.4	40,508.6	204,681	13.54
Night.						
Beef	20	3,800	3,820	----	51,000	14.80
Gabi	5	64.5	19.5	1,675.5	7,285	1.00
Onion	1	16	3	99	490	0.16
Pepper	0.5	----	----	----	----	0.10
Pechay	5	50	17	232	1,315	1.00
Eggplant	5	53.5	22.5	307	2,185	2.00
Upo	5	25	4.5	167	830	0.80
Salt	1	----	----	----	----	0.02
Corn	35	3,220	665	26,390	127,750	5.25
Coconut	10	570	5,060	2,790	60,800	1.20
Sugar	1	----	----	1,000	4,000	0.15
		7,799	9,611.5	32,660.5	255,655	26.48
JANUARY 25, 1922.						
Morning.						
Salmon, 39 cans	18	3,924	2,178	----	36,180	5.40
Onion	1	16	3	99	490	0.16
Pepper	0.5	----	----	----	----	0.10
Lard	2	70	1,760	----	16,680	4.50
Pechay	25	250	85	1,160	6,575	5.00
Pork	1	19	862	----	8,090	1.00
Salt	1	----	----	----	----	0.02
Sugar	4	----	----	4,000	16,000	0.60
Rice	35	2,800	105	27,650	125,650	4.20
		7,079	4,993	32,909	209,665	20.98
Milk, 50 glasses, 25 cans, for children only	----	363	440	605	7,850	8.75
Coffee	1.5	----	----	----	----	0.85
		7,442	5,433	33,514	217,515	30.58

TABLE 2.—*Six days' menus, illustrative of the kind and quantity of food given in the experimental feeding of two hundred lepers at Culion Leper Colony, January 21 to 26, 1922*—Continued.

Food.	Weight.	Protein.	Fat.	Carbohydrate.	Fuel value.	Cost.
JANUARY 25, 1922.						
Noon.	*Kilos.*	*g.*	*g.*	*g.*	*Calories.*	*Pesos.*
Salt	1					0.02
Fish	20	3,740	260	220	17,800	6.00
Onion	2	32	6	198	980	0.32
Lard	2	70	1,760		16,680	4.50
Gabi	30	387	117	10,053	43,710	6.00
Squash	8	106.4	34.4	746.4	3,816	1.20
Upo	6	30	5.4	200.4	996	0.96
Pechay	2	20	6.8	92.8	526	0.40
Eggplant	2	21.4	9	122.8	874	0.80
Pepper	1					0.20
Salt	1					0.02
Bread	40	3,680	520	21,240	107,200	8.00
		8,086.8	2,718.6	32,873.4	192,582	28.42
Night.						
Mungo	9	1,989	72	5,292	29,790	1.52
Pepper	0.5					0.10
Squash	8	106.4	34.4	746.4	3,816	1.20
Upo	8	40	7.2	267.2	1,328	1.28
Eggplant	5	53.5	22.5	307	2,185	2.00
Pechay	10	100	34	464	2,630	2.00
Salt	1					0.02
Gabi	20	258	78	6,702	20,140	4.00
Onion	1	16	3	99	490	0.16
Bread	20	1,840	260	10,620	53,600	4.00
		4,393.9	511.1	24,497.6	122,979	16.28
JANUARY 26, 1922.						
Morning.						
Mungo	20	4,420	160	11,760	66,200	3.38
Ubi	10	286	5	2,731	12,420	5.00
Pechay	10	100	34	464	2,630	2.00
Onion	1	16	3	99	490	0.16
Salt	1					0.02
Green pepper	1					0.20
Sugar	4			4,000	16,000	0.60
Rice	35	2,800	105	27,650	125,650	4.25
		7,622	307	46,704	223,390	15.61
Milk, 50 glasses, 25 small cans, for children only		363	440	605	7,850	8.75
Coffee	1.5					0.85
		7,975	747	47,309	231,240	25.21

TABLE 2.—*Six days' menus, illustrative of the kind and quantity of food given in the experimental feeding of two hundred lepers at Culion Leper Colony, January 21 to 26, 1922*—Continued.

JANUARY 26, 1922.						
Food.	Weight.	Protein.	Fat.	Carbohydrate.	Fuel value.	Cost.
Noon.	*Kilos.*	*g.*	*g.*	*g.*	*Calories.*	*Pesos.*
Fish	20	3,740	260	220	17,800	6.00
Lard	4	140	3,520	----	33,360	9.00
Salt	1	----	----	----	----	0.02
Patola	4	25.2	5.2	170	848	1.60
Upo	10	50	9	334	1,660	1.60
Squash	4	53.2	17.2	373.2	1,908	0.60
Gabi	2	25.8	7.8	670.2	2,914	0.40
Onion	0.5	8	1.5	49.5	245	0.08
Banana	2.5	32.5	15	550	2,525	0.55
Papaya	6	65.4	10.2	222	1,272	1.20
Coconut	2.1	119.7	1,062.6	585.9	12,768	0.25
Sugar	1	----	----	1,000	4,000	0.15
Rice	35	2,800	105	27,650	125,650	4.20
		7,059.8	5,013.5	31,824.8	204,950	25.65
Night.						
Mungo	9	1,989	72	5,292	29,790	1.52
Squash	4	53.2	17.2	373.2	1,908	0.60
Eggplant	4	42.8	18	245.6	1,748	1.60
Gabi	1	12.9	3.9	335.1	1,457	0.20
Pechay	5	50	17	232	1,315	1.00
Onion	1	16	3	99	490	0.16
Pepper	1.5	----	----	----	----	0.30
Salt	1	----	----	----	----	0.02
Upo	20	100	18	668	3,320	3.20
Lard	4	140	3,520	----	33,360	9.00
Rice	35	2,800	105	27,650	125,650	4.20
		5,203.9	3,774.1	34,894.9	199,038	21.80

TABLE 3.—*Record of lepers undergoing experimental feeding from January 20 to February 24, 1922, inclusive.*

[Persons dropped were immediately substituted by other individuals.]

No.	Name.	Age.	Sex.	Civil condition.	Occupation.	Height.	Weight.			Stage of leprosy.	Remarks.
							Before experiment.	After six weeks.	Increased or Decreased.		
		Yrs.				*m.*	*Kilos.*	*Kilos.*	*Kilos.*		
1	L. Can	18	M	Single	None	1.5	43.5	41.7	−1.8	Advanced	Missed 1 meal.
2	U. Lor	21	M	do	do	1.64	49.7	52.4	2.7	Middle	
3	A. Lua	21	M	do	Laborer	1.58	34.7	38.5	3.8	Advanced	
4	L. Sor	21	M	do	None	1.6	42.7	44.6	1.9	Middle	
5	F. Alf	16	M	do	Laborer	1.6	44.1	45	0.9	do	
6	A. Sun	20	M	do	do	1.54	50.7	49.7	−1	do	Missed 10 meals, dropped February 2; hospital.
7	M. Arg	25	M	do	None	1.57	44.1	46.2	2.1	Advanced	
8	A. Cab	28	M	do	Laborer	1.60	45.9	49.6	3.7	Middle	Dropped February 4, moved to destino.
9	F. Ber	22	M	do	do	1.59	42.5	45.7	3.2	Advanced	Missed 2 meals.
10	N. Sen	17	M	do	None	1.57	41.5	42.7	1.2	Middle	Do.
11	F. Man	38	M	Widower	do	1.57	39.7	38.5	−1.2	Advanced	Dropped February 28; entered hospital.
12	B. Mar	25	M	Married	Laborer	1.50	45.4	48.7	3.3	do	
13	Y. Y. Sia	22	M	Single	Merchant	1.57	51.7	56.7	5	Incipient	Missed 3 meals; indisposed.
14	P. Bil	18	M	do	Waiter	1.54	41.1	43.8	2.7	Middle	
15	V. Buc	48	M	Married	Laborer	1.63	52.7	52.7		Advanced	Missed 2 meals; dropped February 10; destino.
16	S. Gar	19	M	Single	None	1.65	42.6	44.6	2	Advanced	
17	V. de Alc	40	M	Married	do	1.58	54.7	59.3	4.6	Middle	

TABLE 3.—*Record of lepers undergoing experimental feeding from January 20 to February 24, 1922, inclusive*—Ctd.

No.	Name.	Age.	Sex.	Civil condition.	Occupation.	Height.	Weight.			Stage of leprosy.	Remarks.
							Before experiment.	After six weeks.	Increased or Decreased.		
		Yrs.				*m.*	*Kilos.*	*Kilos.*	*Kilos.*		
18	G. Abe	28	M	Single	Laborer	1.51	45.7	47.9	2.2	Advanced	
19	F. Pon	22	M	do	do	1.49	36.6	39	2.4	do	Missed 2 meals.
20	P. Buc	21	M	do	None	1.54	45.6	43.7	—1.9	Middle	Missed 2 meals.
21	G. Cab	43	M	Married	Laborer	1.59	45.1	51.8	6.7	do	Missed 1 meal.
22	C. Ave	15	M	Single	Musician	1.48	33.5	36.1	2.6	do	Do.
23	C. Gin	22	M	do	None	1.57	53.2	55.1	1.9	do	
24	T. de Zaf	29	M	Married	do	1.60	49.8	53.9	4.1	Advanced	Missed 3 meals.
25	C. Ven	38	M	do	do	1.47	36.7	39.4	2.7	Middle	Missed 1 meal.
26	L. Alb	35	M	do	do	1.48	37.7	39	1.3	Advanced	Missed 6 meals; dropped January 29; hospital.
27	R. B. Box	32	M	Single	do	1.56	42.9	44.8	1.9	Middle	Missed 3 meals.
28	E. Cab	21	M	do	do	1.58	51.4	55	3.6	Incipient	
29	E. Est	22	M	do	Laborer	1.60	44.7	52.5	7.8	Middle	
30	F. Luc	21	M	do	None	1.61	47.7	49.6	1.9	Incipient	
31	J. Tri	47	M	Married	do	1.65	45.7	52.6	6.9	Middle	Missed 1 meal.
32	J. Ven	38	M	do	Laborer	1.57	42.9	45.4	2.5	Advanced	
33	L. Sin	17	M	Single	None	1.49	38.7	42.1	3.4	Middle	
34	A. Pas	18	M	do	do	1.64	43.4	43.2	—0.2	Incipient	Missed 1 meal.
35	M. Per	35	M	Married	Laborer	1.62	49.1	51.9	2.8	Middle	Missed 2 meals.
36	S. de Gui	37	M	do	do	1.55	49.7	48.7	—1.0	do	Missed 1 meal.
37	J. Jac	25	M	Single	None	1.46	48.7	49.2	0.5	do	
38	P. Zul	37	M	Married	Laborer	1.60	45.7	49.6	3.9	Advanced	Dropped February 8; destino.
39	N. Est	24	M	do	None	1.57	51.7	53.0	1.3	Middle	Missed 2 meals.
40	S. Cru	50	M	do	do	1.55	44.7	43.3	—1.4	Advanced	

41	B. Dig	50	M	do	Laborer	1.62	54.7	55.0	0.3	Middle	Dropped February 8; destino.
42	R. Boo	32	M	do	None	1.63	49.7	51.4	1.7	do	Missed 1 meal.
43	F. All	27	M	do	do	1.60	51.7	51.5	−0.2	do	Missed 1 meal; dropped February 4; hospital.
44	J. Can	24	M	do	do	1.64	50.0	48.8	−1.2	do	Missed 3 meals; dropped.
45	C. Ill	31	M	Single	Laborer	1.51	34.7	37.8	3.1	Advanced	
46	B. Bue	30	M	Married	Carpenter	1.51	44.7	37.8	−6.9	Middle	Missed 13 meals; dropped February 11; hospital.
47	M. Arc	35	M	do	Laborer	1.00	45.7	44.9	−0.8	Advanced	Missed 14 meals; dropped February 2; illness.
48	T. Ray	30	M	do	Shoemaker	1.60	44.5	46.4	1.9	do	Dropped February 13; hospital; missed 15 meals.
49	S. Nol	42	M	do	Laborer	1.62	49.3	53.8	4.5	Middle	
50	A. Can	38	M	do	None	1.52	43.3	47.9	4.6	do	Missed 3 meals.
51	F. Bal	38	M	do	Laborer	1.63	61	63.2	2.2	do	Missed 5 meals; dropped February 5; P. Works.
52	E. Qui	18	M	Single	do	1.63	50.4	52	1.6	do	Missed 1 meal.
53	B. Tap	37	M	Married	Attendant	1.60	46.8	49.4	2.6	Advanced	
54	N. Taa	21	M	Single	Salesman	1.48	49.3	49.2	−0.1	Middle	Missed 19 meals; dropped February 28; hospital.
55	J. Esp	23	M	do	Shoemaker	1.55	49.8	50.8	1	Advanced	Missed 2 meals.
56	M. Bor	23	M	do	None	1.61	46.8	47.3	0.5	Middle	
57	F. Wan	37	M	do	Musician	1.54	39.7	44.5	4.8	Advanced	Missed 2 meals.
58	R. B. Ro	21	M	do	None	1.59	43.3	43.6	0.3	Incipient	
59	F. Lab	25	M	Married	Shoemaker	1.63	55.7	59.3	3.6	do	
60	M. Loz	70	M	do	None	1.56	49.9	54	4.1	Middle	

TABLE 3.—*Record of lepers undergoing experimental feeding from January 20 to February 24, 1922, inclusive*—Ctd.

No.	Name.	Age.	Sex.	Civil condition.	Occupation.	Height.	Weight.			Stage of leprosy.	Remarks.
							Before experiment.	After six weeks.	Increased or Decreased.		
		Yrs.				*m.*	*Kilos.*	*Kilos.*	*Kilos.*		
61	M. Man	50	M	Married	Laborer	1.50	49.7	52.4	2.7	Middle	
62	Q. Fie	33	M	do	None	1.51	54.6	55.3	0.7	Advanced	
63	E. Mul	28	M	do	Attendant	1.60	56.7	55.8	—0.9	Incipient	
64	J. Dav	24	M	Single	None	1.50	51.7	53	1.3	do	
65	F. San	26	M	Married	do	1.59	53.7	52.7	—1	Advanced	Missed 15 meals; dropped February 28; hospital.
66	T. Pag	37	M	Single	do	1.57	43.1	42.3	—0.8	Middle	
67	J. Tre	27	M	Married	Laborer	1.68	54.7	58.9	4.2	Incipient	Missed 1 meal.
68	L. Lam	22	M	Single	None	1.56	44.7	48.4	3.7	Middle	
69	C. Bad	53	M	do	Laborer	1.62	62.7	62.7		do	Dropped February 4; moved to destino.
70	E. Bay	28	M	Widower	Waiter	1.54	42.7	44.2	1.5	Incipient	
71	J. Ron	35	M	Married	Laborer	1.59	60	60		Middle	
72	F. Maz	23	M	Single	do	1.57	44.7	52.4	7.7	Incipient	Missed 1 meal.
73	V. Rey	38	M	Married	None	1.60	49.7	51.5	1.8	Middle	
74	T. Rec	32	M	do	do	1.57	42.8	42.4	—0.4	Advanced	Missed 29 meals; dropped February 17; hospital.
75	R. Rib	44	M	do	Laborer	1.43	49.7	52.2	2.5	Middle	
76	M. Liz	34	M	do	do	1.51	42.7	46.1	3.4	do	Missed 16 meals; dropped February 17; hospital.
77	B. Sol	29	M	Single	do	1.60	44.7	49.8	5.1	do	Missed 10 meals; dropped February 17; hospital.

78	P. Dac	23	M	do	None	1.61	44.7	45.7	1	do	Dropped February 8; hospital.
79	M. Man	42	M	Married	do	1.65	56.6	57.5	0.9	do	
80	B. Ari	28	M	do	do	1.60	51.4	52.5	1.1	do	Missed 2 meals.
81	V. Mer	33	M	do	Musician	1.53	45.7	48.9	3.2	Advanced	Missed 3 meals.
82	A. Dem	22	M	Single	Waiter	1.58	44.7	46.6	1.9	Middle	
83	B. Noc	45	M	Married	None	1.58	54.7	54.7		Advanced	Missed 23 meals; dropped February 3; hospital.
84	J. Faj	20	M	Single	do	1.58	37.9	40.4	2.5	Middle	
85	D. Por	37	M	do	do	1.58	47.2	47	−0.2	do	Missed 10 meals; dropped February 13; destino.
86	C. Ray	30	M	Married	do	1.59	46.6	44.2	−2.4	Advanced	Missed 21 meals; dropped February 17; hospital.
87	S. Iba	25	M	Single	Waiter	1.62	48.7	52.1	3.4	Incipient	
88	D. Pec	31	M	Married	None	1.55	42.3	45.2	2.9	do	
89	A. Gue	50	M	do	do	1.65	57.4	59.6	2.2	Middle	
90	E. Abr	15	M	Single	do	1.54	37.6	41	3.4	Advanced	
91	D. Her	19	M	do	do	1.65	44.7	52.3	7.6	Incipient	
92	F. Per	17	M	do	do	1.53	42.3	43.3	1	Middle	Missed 1 meal.
93	M. Lla	42	M	do	do	1.58	52.3	54.3	2	do	Missed 2 meals.
94	P. For	28	M	do	Tailor	1.63	52.7	53.3	−0.4	do	Dropped February 12, sickly, T. B.?
95	E. Tol	52	M	Married	None	1.59	45.7	46.8	1.1	do	Missed 1 meal.
96	L. Tad	32	M	Single	do	1.52	44.7	49	4.3	Advanced	
97	F. Cal	25	M	do	Laborer	1.60	59.8	59.6	−0.2	do	
98	J. de Ver	25	M	do	None	1.53	57.9	40.4	2.5	Middle	
99	P. de Guz	26	M	do	Shoemaker	1.58	44.4	45.2	0.8	do	Missed 4 meals.
100	T. Pab	23	M	do	None	1.59	38.7	40.3	1.6	Advanced	Missed 8 meals; dropped February 18; sickly.
101	M. Nor	25	M	do	Shoemaker	1.70	51.3	56.3	5	Middle	
102	M. Sev	28	M	Widower	None	1.58	50.8	52.2	1.4	do	

TABLE 3.—*Record of lepers undergoing experimental feeding from January 20 to February 24, 1922, inclusive*—Ctd.

No.	Name.	Age.	Sex.	Civil condition.	Occupation.	Height.	Weight.			Stage of leprosy.	Remarks.
							Before experiment.	After six weeks.	Increased or Decreased.		
		Yrs.				*m.*	*Kilos.*	*Kilos.*	*Kilos.*		
103	A. Ped	31	M	Single	Policeman	1.59	50.7	53.9	3.2	Middle	
104	M. Bai	21	M	do	None	1.64	44.1	48.2	4.1	Advanced	
105	A. Tio	22	M	do	do	1.52	44.3	46.2	1.9	Middle	Missed 2 meals.
106	B. Tra	24	M	Married	Laborer	1.55	44.7	50.3	5.6	do	
107	F. Jip	23	M	do	Tailor	1.61	42.1	43.5	1.4	Incipient	Missed 1 meal.
108	A. Ave	21	M	Single	None	1.50	37.6	40.4	2.8	Advanced	
109	A. Rey	26	M	do	Laborer	1.61	49.7	52.9	3.2	Middle	Missed 3 meals; dropped February 10; lame.
110	L. Sum	15	M	do	do	1.40	33.5	35.4	1.9	do	
111	A. Rey	21	M	do	Musician	1.51	45.7	48.4	2.7	do	Missed 4 meals.
112	E. Kal	53	M	Married	Laborer	1.55	50.7	53.1	−2.4	do	
113	C. Ram	16	M	Single	None	1.53	38.5	40.2	1.7	Advanced	
114	T. Sab	16	M	do	Musician	1.52	40.5	43.4	2.9	Incipient	Missed 2 meals.
115	P. de Jes	21	M	do	Laborer	1.63	43.6	45.9	2.3	Middle	Do.
116	M. Coc	16	M	do	None	1.51	41.3	41.6	0.3	Incipient	Missed 8 meals.
117	S. Esc	15	M	do	do	1.47	30.7	34.4	3.7	Middle	
118	M. Mal	36	M	Married	Laborer	1.63	55.7	57.6	1.9	do	
119	R. Ell	23	M	Single	Musician	1.65	48.7	51.3	2.6	Advanced	
120	B. Reb	25	F	Widow	None	1.41	40.3	42.5	2.2	Middle	
121	M. Rum	50	F	do	do	1.47	40.7	42.7	2	do	
122	P. Pue	35	F	Single	do	1.42	27.6	29.1	1.5	do	
123	E. Ora	30	F	Married	do	1.46	42.7	43.5	0.8	do	
124	A. Sal	38	F	do	do	1.49	41.7	44.6	2.9	do	
125	F. Uga	20	F	do	do	1.40	30.2	33.2	3	do	

126	J. Qui	24	F	Single	do	1.46	39.7	39.9	0.2	do	Dropped February 3, on insistent request.
127	A. Pin	34	F	Married	do	1.51	38.2	40.1	1.9	do	Dropped February 10, on insistent request.
128	M. Bol	65	F	do	Seller	1.50	41.5	46.6	5.1	do	
129	C. Ali	45	F	do	None	1.45	39.7	44.6	4.9	do	
130	J. Mir	70	F	do	do	1.42	42.2	44.5	2.3	do	Missed 2 meals.
131	D. Ros	30	F	do	do	1.44	37.7	37.7		do	Missed 17 meals; dropped February 18.
132	M. Lov	18	F	do	do	1.47	44.7	46.3	1.6	do	Missed 1 meal.
133	A. Gui	37	F	do	do	1.47	40.7	43.4	2.7	Advanced	
134	F. Car	45	F	do	do	1.52	63.7	64.1	0.4	Middle	Missed 2 meals; dropped February 3, on own request.
135	J. Noc	21	F	do	do	1.42	32.7	31.9	−0.8	do	Dropped February 3, on own request.
136	J. Sal	57	F	Widow	do	1.40	32.1	31.4	−0.7	Advanced	
137	E. Cab	26	F	do	Seamstress	1.45	41.1	44.1	3	Middle	
138	S. Seb	50	F	do	None	1.44	29.7	29.8	0.1	do	
139	I. Jug	29	F	do	Seamstress	1.54	48.1	49.5	1.4	do	
140	E. Cli	53	F	do	None	1.42	37.7	37.3	−0.4	Advanced	Missed 12 meals; dropped February 10; hospital.
141	M. Mar	82	F	do	do	1.55	55.7	59.5	3.8	Middle	
142	G. Ube	50	F	do	do	1.51	35.6	36.2	0.6	Advanced	
143	A. Val	66	F	do	do	1.45	34.8	38.5	3.7	Middle	
144	A. Bau	11	M	Boy	do	1.27	21.1	26.1	5	Incipient	
145	B. Tan	14	M	do	do	1.48	33.9	33.8	−0.1	do	Missed 1 meal.
146	M. Puj	13	M	do	do	1.36	27.7	29.9	2.2	Middle	
147	L. Sat	14	M	do	do	1.39	34.7	36.9	2.2	Incipient	
148	J. Riv	14	M	do	do	1.39	30.7	33.2	2.5	Middle	Missed 2 meals.
149	P. Bri	12	M	do	do	1.25	24.7	27.0	2.3	Incipient	Do.
150	R. Ber	11	M	do	do	1.24	20.7	23.4	2.7	do	
151	N. Bao	10	M	do	do	1.21	20.7	23.9	3.2	do	

TABLE 3.—*Record of lepers undergoing experimental feeding from January 20 to February 24, 1922, inclusive*—Ctd.

No.	Name.	Age.	Sex.	Civil condition.	Occupation.	Height.	Weight.			Stage of leprosy.	Remarks.
							Before experiment.	After six weeks.	Increased or Decreased.		
		Yrs.				*m.*	*Kilos.*	*Kilos.*	*Kilos.*		
152	B. Bar	11	M	Boy	None	1.29	24.7	26.4	1.7	Incipient	
153	C. Rub	15	M	do	do	1.40	29.7	31.8	2.1	do	
154	D. Pin	7	M	do	do	1.20	19.1	21.0	1.9	do	
155	E. Gim	10	M	do	do	1.16	14.2	16.3	2.1	do	
156	G. Man	9	M	do	do	1.28	20.8	26.0	5.2	do	
157	A. Tay	6	F	Girl	do	1.03	14.7	15.8	1.1	do	
158	I. Yla	7	F	do	do	1.13	15.6	17.3	1.7	do	
159	A. Man	8	F	do	do	1.11	17.5	19.3	1.8	do	
160	M. Sol	12	F	do	do	1.40	27.5	28.8	1.3	do	
161	G. Dun	15	F	do	do	1.41	41.7	43.1	1.4	do	
162	V. Puj	12	F	do	do	1.34	21.7	27.0	5.3	do	
163	L. Enc	15	F	do	do	1.51	35.4	37.6	2.2	do	
164	C. Isa	13	F	do	do	1.40	29.5	32.0	2.5	Advanced	
165	M. Cas	10	F	do	do	1.14	16.8	17.5	0.7	Incipient	
166	B. Rod	11	F	do	do	1.26	20.5	24.1	3.6	do	
167	E. Baj	15	F	do	do	1.40	35.5	32.0	−3.5	do	Dropped February 18; sickly.
168	A. Ser	10	F	do	do	1.16	18.7	19.9	1.2	do	
169	F. Guz	11	F	do	do	1.20	25.6	27.4	1.8	do	
170	I. Bar	12	F	do	do	1.30	19.7	23.5	3.8	Advanced	
171	S. Ide	13	F	do	do	1.58	36.3	37.5	1.2	Middle	
172	A. Cab	12	F	do	do	1.38	29.9	31.8	1.9	Incipient	
173	V. Cab	12	F	do	do	1.35	28.7	30.2	1.5	do	
174	A. Rep	14	F	do	do	1.38	33.7	35.5	1.8	Middle	
175	V. Bag	10	F	do	do	1.26	23.4	24.2	0.8	Incipient	
176	A. Bay	14	F	do	do	1.36	37.7	38.5	0.8	Middle	

177	S. Rol	11	F	do	do	1.32	28.4	29.6	1.2	Incipient	
178	A. Ali	10	F	do	do	1.57	19.7	25.4	5.7	do	
179	P. Bid	13	F	do	do	1.36	25.5	27.1	1.6	do	Missed 1 meal.
180	A. Abe	14	F	do	do	1.26	24.1	25.5	1.4	do	Missed 20 meals; varicella.
181	S. Enc	12	F	do	do	1.29	25.4	24	−1.4	do	Missed 10 meals; sickly.
182	M. Ung	12	F	do	do	1.35	26.7	29.2	2.5	do	
183	J. Med	10	M	Boy	do	1.17	17.1	20.4	3.3	do	
184	F. Ros	13	M	do	do	1.34	27.8	31.6	3.8	Middle	
185	F. Sun	14	M	do	do	1.40	29.1	31.3	2.2	Incipient	
186	F. Bag	13	M	do	do	1.30	24.5	26.4	1.9	Advanced	
187	T. Esp	10	M	do	do	1.15	17.3	18.4	1.1	Incipient	
188	C. Ale	12	M	do	do	1.41	28.5	30.6	2.1	Middle	
189	C. Esc	9	M	do	do	1.33	28.3	31.2	2.9	do	
190	M. Gay	12	M	do	do	1.30	20.7	20.7		do	Missed 20 meals; dropped February 13; hospital.
191	R. Ara	12	M	do	do	1.32	19.7	24.8	5.1	Incipient	
192	G. Car	8	M	do	do	1.20	17.9	19.8	1.9	do	
193	F. Can	12	M	do	do	1.35	28.9	28.3	−0.6	Advanced	
194	N. Res	24	M	Married	Cook	1.44	48.5	48.8	0.3	do	
195	A. Ben	29	M	Single	Waiter	1.49	39.7	42.8	3.1	Middle	
196	L. Bis	24	M	do	do	1.69	45.2	45.6	0.4	do	
197	A. Bis	26	M	do	do	1.61	47.8	48.1	0.3	do	
198	J. Pac	25	M	do	Cook	1.59	66.4	66.4		Advanced	
199	A. Cos	21	M	do	Waiter	1.57	48.5	48.7	0.2	Middle	
200	D. End	24	M	Married	do	1.66	59.7	61.1	1.4	do	

ILLUSTRATION

PLATE 1

FIG. 1. The outdoor leper kitchen erected for the experimental feeding at Culion Leper Colony.

2. Some of the leper children in the feeding experiment.

3. Ensemble of the feeding experiment.

FIG. 1. THE OUTDOOR KITCHEN.

FIG. 2. CHILDREN IN THE FEEDING EXPERIMENT.

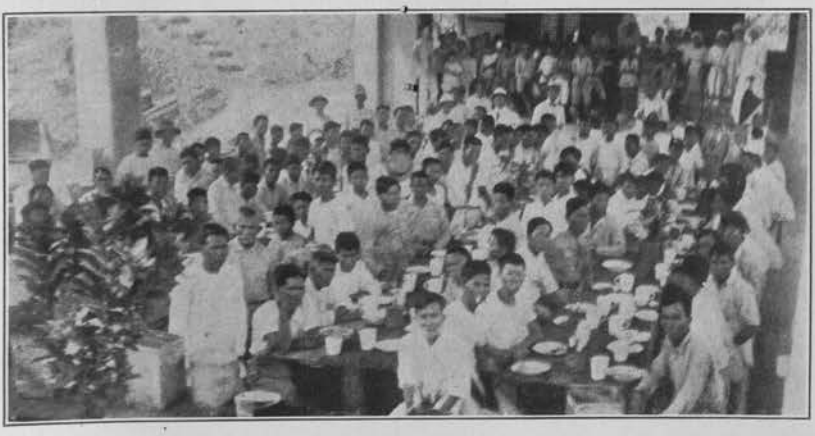

FIG. 3. ENSEMBLE OF THE FEEDING EXPERIMENT.

AN INTERESTING NEW WATER STRIDER FROM FORMOSA

By TEISO ESAKI

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ONE PLATE

During a trip to Formosa, I made a collection of insects on September 25, 1921, at Sôsan near Taihoku, with Mr. Ryoichi Takahashi, of the section of applied zoölogy, Department of Agriculture, Government Research Institute of Formosa. In the collection I have found a species of the family Gerridæ, interesting both systematically and ecologically. A small number of the same species, moreover, were captured by us at Shinten near Taihoku, several days later; also two specimens, collected by the late I. Nitobe at Kusukusu near Kôshun, were found in the collection kept at the Government Research Institute of Formosa in Taihoku. This insect was subsequently found to be new to science, and to belong to a new genus.

Genus **RHYACOBATES** novum

Head longer than broad between eyes, the latter being moderately emarginate interiorly; portion of head in front of eyes extended and longer than rest of head, almost pentagonal in shape; antennæ not longer than body, with first joint much longer than the three other joints together, second and fourth joints subequal in length, third slightly longer; rostrum scarcely passing anterior coxæ.

Pronotum much shorter than head, anterior margin straight, posterior slightly concave; mesonotum about three times as long as pronotum; anterior femora thickened and longer than tibiæ, the last with a distinct apical spine; intermediate and posterior femora about subequal in length, very slender, a little shorter than twice the length of intermediate tibiæ in the former, while in the latter about three times as long as posterior tibiæ. Intermediate tibiæ with a fringe of long hairs. First intermediate tarsal joint about eight times the length of second; posterior

tarsal joint very short, the second being slightly longer than the first; all these tarsi without claws.

In the female, abdomen with the lateral margins rolled up and sometimes in contact with each other at the central axis, so that the morphological dorsal side of the abdomen is invisible; anal segment forming a thin-walled tubelike structure with lateral sides pointed posteriorly.

Type, *Rhyacobates takahashii* sp. nov.

This genus is somewhat allied to *Jucundus* Distant, but differs from it in the shape of the head, the considerable length of the first joint of the antennæ and of the intermediate and posterior femora, the apical spine of the anterior tibiæ, the fringe of long hairs on the intermediate tibiæ, the structure of the intermediate and posterior tarsi, and the peculiar abdominal structure in the female. Only the apterous form is known.

Rhyacobates takahashii sp. nov. Plate 1.

Head longer than broad between the eyes, dark brown above, pale yellowish brown beneath, with a somewhat fork-shaped central black fascia on vertex which is bifurcate posteriorly; eyes large, prominent, and black, antennæ not longer than body, black, with first joint slightly thicker and much longer than the three other joints together, second and fourth joints subequal in length, third slightly longer; rostrum scarcely passing anterior coxæ, with apex of third segment and entire fourth segment black.

Pronotum much shorter than head, anterior margin straight, posterior slightly concave; shining black above with a large central brown spot touching posterior margin; prosternum pale yellowish brown, posterior lateral sides silver gray pubescent. Meso- and metanotum together somewhat globose, shining black, with a longitudinal dark brown fascia and somewhat indistinct lateral silver gray striæ, posterior ends of striæ somewhat thickened on mesonotum, and a thin silver gray stria on the central axis of metanotum. Meso- and metasternum silver gray, thickly pubescent.

Anterior acetabulæ, coxæ, trochanters, and femora brown; a spot on the acetabulæ, apical end of trochanters, and two longitudinal lines on anterior and lateral sides of femora black; tibiæ and tarsi black, base of former brown. Trochanters coarsely downy; femora very much thickened, much longer than tibiæ, the last with a distinct apical spine; first tarsi distinctly longer

than second in male, and the former almost twice as long as the latter in the female; claws inserted before apex of tarsi. Intermediate and posterior coxæ, trochanters, and basal one-third of femora brown; rest of femora, tibiæ, and tarsi black; intermediate and posterior femora about subequal in length, very long and slender, the former being about twice as long as the intermediate tibiæ and the latter about three times the length of the corresponding ones; intermediate tibiæ with a fine fringe of long hairs, though somewhat indistinct in the dried specimens; tarsi very much thinner than tibiæ, without claws; first intermediate tarsal joint about eight times as long as second; posterior tarsi very short, second joint slightly longer than first.

Abdomen in male somewhat shining black above; apex of genital segment and below brown, the latter somewhat silvery pubescent; in the female the end of abdomen turns upward markedly, the morphological dorsal side scarcely visible, as the ventrolateral sides roll up considerably. The apparent dorsal side except anal segment black with silver pubescence, ventral side and anal segment pale brown with similar pubescence; anal segment thin walled, forming a tubelike structure, its upper margin black and the lateral sides pointed posteriorly. Length of body, male, 6.5 millimeters; female, 9.5.

Holotype, female,[1] captured at Sôsan near Taihoku on September 25, 1921, by T. Esaki, allotopotype, male, paratopotypes, and paraidiotypes from Shinten near Taihoku are all in my collection. There are also two specimens from Kusukusu near Kôshun in the collection of the section of applied zoölogy, Department of Agriculture, Government Research Institute of Formosa in Taihoku.

This species is named in honor of my friend Mr. R. Takahashi, to whom I acknowledge indebtedness for many favors.

This curious water strider was found at first on a very rapid stream in a rocky ravine at Sôzan. The insects glide swiftly on the surface of the water in all directions and are hardly recognizable owing to the disturbance of the water. They look, however, somewhat like whirligig beetles. Some of them were found climbing on the rocks near by. Numbers of specimens in copula were also captured. Numerous examples were found on the Shinten River which is a very much larger stream than

[1] I purposely took a female as holotype, because some important generic characters are represented only in that sex.

the Sôzan. Here also they live on a rapid current, but at Shinten only the males and the nymphs of the last instar were found. The nymphs were not seen at Sôzan.

The considerable length of the first joint of the antennæ and of the intermediate and posterior femora has been acquired in all probability as an adaptation to the habitat of this insect. The fringe of long hairs on the intermediate tibiæ seems of service in keeping the insect from getting wet. This character is also found in *Halobates*, which inhabits the sea. In the females of *Ptilomera*, a similar fringe occurs on the intermediate femora. The peculiar abdominal structure in the female of this insect seems to have some adaptive significance to its life on running water; at copulation the rolled-up lateral margins firmly clasp the abdomen of the mate on the back. The copulatory organs of both sexes are entirely enveloped by the tube-like anal segment of the female. The insects when captured in copula and placed in a small vial continue the act for a fairly long time, contrary to any other species of the Gerridæ known to me.

ILLUSTRATION

PLATE 1. RHYACOBATES TAKAHASHII SP. NOV.

FIG. 1. Female.
2. Head of female, lateral view.
3. Antenna.
4. Anterior leg of female.
5. Intermediate tarsus.
6. Posterior tarsus.
7. Abdomen of male, dorsal view.
8. Hinder part of abdomen of female, lateral view.

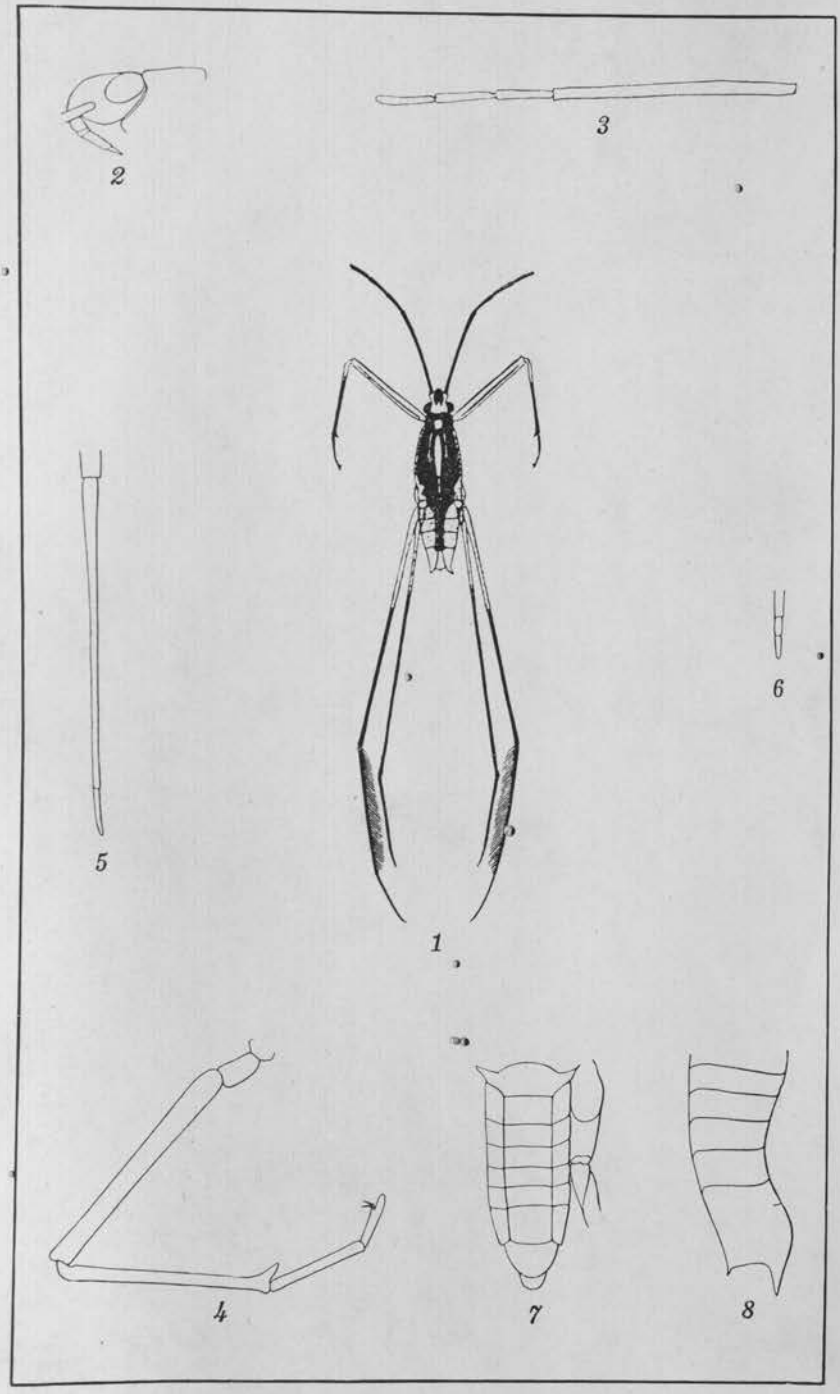

PLATE 1. RHYACOBATES TAKAHASHII G. ET SP. NOV.

THE CHINESE WHITE-WAX SCALE, ERICERUS PELA CHAVANNES

By INOKICHI KUWANA

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TWO PLATES

INTRODUCTION

My attention was first called to the Chinese white-wax scale, *Ericerus pela* Chavannes,[1] during the summer of 1918, and since that time I have had it under more or less continuous observation for two years. The results of the study are recorded in this paper.

Besides the commercial value of its wax product, the insect possesses considerable interest from other points of view, especially that of its biology. Although Sasaki (17) and Yano (20) studied its life history to a considerable extent, the notes published by them on the biology and on the description of the various stages leave many points untouched.

The object of this paper is to present some additional information about the insect, especially as to its morphology. The detailed descriptions of all stages from the egg to the adult, both male and female, were made from living and freshly mounted material collected during the course of the study, and the notes on the life history and habits are from personal observation.

The original material for this study, consisting of females with eggs, was obtained by me at Okudo-mura near Tokyo City, on the branches of *Fraxinus bungeana* var. *pubinervis*, in the early summer of 1918. From these eggs the scale was bred on the same host and on *Ligustrum ibota* in the insectary of the Imperial Plant Quarantine Station at Yokohama. My thanks are due to Mr. K. Katsumata and to the late Mr. K. Kobayashi, who kindly assisted me in the insectary. The figures were drawn by Nobu Kuwana under my direction.

[1] A member of the Coccidæ, subfamily Lecaniinæ (according to Fernald's catalogue (6) it should be Coccinæ).

DESCRIPTIONS

MATURE FORMS

Adult female.—Hemispherical in form, the thoracic region strongly convex and barnaclelike (Plate 2, figs. 14, 15, 16). Average size about 1.2 to 1.5 millimeters in diameter. During pregnancy the body of the female gradually becomes enlarged and at the end of oviposition is nearly globular in form when attached to the host singly, but naturally more or less deformed by mutual pressure when congregated in numbers (Plate 2, fig. 2). The diameter of the largest ones observed was over 10 millimeters. The dorsal surface is dark reddish brown with blackish patches of various sizes over the entire surface. The minute pores are found near the small patches, and from these is excreted the waxy substance that covers the surface. The ventral surface is pale yellow.

The margin of the body is provided with a row of sharp spines, of which the longest observed was about 42 μ. The thoracic incisions are shallow, each with five or more blunt spines (Plate 1, fig. 1, *c*), these being slightly longer than the marginal one and subequal in length. A row of about twenty pores extends from the spiracle to the margin. The mouth parts are well chitinized, with the rostral setæ short. The antennæ and legs are rather small and weak.

The antennæ (Plate 1, fig. 1, *a*) are of six joints,[2] joint 3 the longest and 6 next to the longest, each joint with fine hairs, these being most numerous on the apical joint. The measurements of the antennal joints in microns are as follows:[3]

Joint.		
	μ.	μ.
Second	26	24
Third	45	48
Fourth	21	21
Fifth	21	21
Sixth	36	36

The three pairs of legs are similar in general shape, slender, with a few fine hairs; femora slightly enlarged at the middle

[2] Sasaki (17) states that the young female possesses 8- instead of 6-jointed antennæ.

[3] In this and succeeding tabulations of antennal measurements the length of the first joint is omitted.

portion; tibiæ nearly straight; tarsi tapering apically; claw large and curved; two pairs of conspicuously knobbed digitules (Plate 1, fig. 1, *b*), the pair on the tarsi being the larger. The lengths of the different parts of the hind leg are: Coxa, 60 μ; trochanter and femur, 87 μ; tibia, 72 μ; tarsus, 66 μ; claw, 21 μ. Small pores and fine spiny hairs are sparsely distributed over the dorsum. Anal cleft not deep. Anal plates (Plate 1, fig. 1, *d*) together forming a short oval, almost a circle; the inner margins of the plates are more or less parallel, wavy, but nearly straight, the outer margins almost uniformly curved from base to apex; four dorsal spines near the apex; the ventral surface with six rather long hairs in a row nearly parallel with the inner margin. Anal opening with eight prominent hairs.

Adult male.—Average meaurements: Length of body (exclusive of the style), 2.17 millimeters; width at the thorax, 0.84; antennæ, 1.89; wing expanse, 5; style, 0.48. General color orange yellow with the thoracic region darker; the legs and antennæ pale brown.

Head nearly triangular and bearing six pairs of eyes situated as follows: One large pair on the dorsal side; a smaller pair back of the larger ones; a larger pair, somewhat oval, on the ventral side; and the remaining three pairs, which are small and round, on the sides of the vertex between the larger dorsal and ventral pairs.

Antennæ consisting of ten joints; joint 1 is short and broad, 2 longer than 1 and rather broad, and the others slender; very hairy, the distal joint with three knobbed hairs in addition to the fine ones. The measurements of the antennal joints are as follows:

Joint.				
	μ.	μ.	μ.	μ.
Second	56	60	56	54
Third	266	280	238	252
Fourth	290	280	252	266
Fifth	308	294	280	280
Sixth	322	308	280	280
Seventh	252	252	210	210
Eighth	224	210	196	196
Ninth	154	140	140	140
Tenth	196	112	168	182

The thorax is large, elongate, and much broader than the head; color the same as the head except that the mesothorax

bears two broad purplish brown bands, which lie close to the lateral margins in such a manner as to inclose a nearly hexagonal orange yellow area. The metathorax is marked on its side with an oblique dark brownish streak. Legs rather long, slender, and very hairy; tibiæ very long and nearly twice as long as the femur and bearing a single spine at its distal end; claw long and simple, two pairs of prominent knobbed digitules. The measurements of the different parts of the hind leg are: Coxa, 196 μ; trochanter plus femur, 399 μ; tibia, 756 μ; tarsus, 234 μ; claw, 51 μ. Wings nearly transparent, with costal margin light brown and slightly iridescent; a single vein is present, which begins at the base of the wing and very soon branches, one branch paralleling the costal margin and the other extending toward the anal distal margin. The club-shaped halteres are brownish, and each bears three hooks, which catch in a pocket on the anal margin of the wing.

The abdomen terminates in a pointed style consisting of two long white wax filaments, one arising on each side of the eighth abdominal segment and extending posteriorly. Each of the filaments arises from a number of pores with short spiny hairs and two longer ones, the long hairs being enveloped by the wax filament.

IMMATURE FORMS

The egg.—The eggs are elongate-oval, 0.43 millimeter in length and 0.22 in width. Some are very pale yellow, while others have a slight brownish shade; that is to say, they are slightly deeper in color. The lighter ones produce male larvæ and the darker, female.

The first-stage larva, female.—The body is long-oval in form (Plate 2, fig. 4), widest in the thoracic region, gradually narrowing toward the caudal end, and nearly flat. Pale brownish orange, with the median line dark, the antennæ and legs pale, and the eyes dark brown. Length, 0.60 millimeter; width, 0.36.

After becoming attached to the host the body becomes pale orange gray with white spots at the thoracic incisions, and toward the end of this stage the dorsum becomes more or less convex. Antennæ and legs are comparatively large and slender. The antennæ consist of six joints,[4] each joint bearing a few long hairs, these being most numerous on the apical joint; joint

[4] Sasaki[17] states that the antennæ of newly hatched larvæ consist of eight joints, instead of six as stated in the present paper.

6 is the longest, 3 next to the longest, 4 and 5 subequal, and joint 1 the shortest. The measurements are as follows:

Joint.				
	μ.	μ.	μ.	μ.
Second	18	20	21	18
Third	39	39	35	42
Fourth	15	15	18	18
Fifth	18	18	18	15
Sixth	39	39	39	48

The three pairs of legs are similar; the tibiæ slightly longer than the tarsi; claws large and simple, with the digitules large and knobbed. The measurements of the different parts of the hind leg are: Coxa, 41 μ; trochanter and femur, 67 μ; tibia, 64 μ; tarsus, 45 μ; claw, 24 μ.

The margin of the body bears fine spiny hairs which are longer toward the abdominal end; thoracic incisions with two blunt tracheal spines about 12 μ in length, and usually with three or four pores between the spiracles and the margin. Anal plates with a long apical hair and a few spiny ones near the base, the former measuring about 270 μ. The anal opening bears six hairs.

The second-stage larva, female.—The body is ovate in outline, the thoracic region being the broadest and tapering gradually toward both ends; dorsum more or less convex and the median line raised. Thoracic incisions slight and the anal cleft deep. Pale yellow with the median line yellow; eyes dark brown; the region of the anal cleft pale brown; the legs and antennæ pale.

After the insect becomes settled on the host the color becomes pale yellowish green with the margins somewhat purple. Before the second molt takes place the body becomes much convex and the marginal waxy filaments prominent, the longer ones measured being about 0.2 millimeter. The body measures at this time 1.2 to 1.3 millimeters.

Antennæ 6-jointed, joint 3 being the longest, and each bears fine hairs (Plate 1, fig. 2, *a*). The measurements are as follows:

Joint.				
	μ.	μ.	μ.	μ.
Second	18	18	15	18
Third	38	39	39	39
Fourth	18	18	21	21
Fifth	18	17	21	21
Sixth	33	33	36	33

The legs are similar, but the anterior pairs much shorter. The measurements of the different parts of the hind leg are: Coxa, 51 μ; trochanter plus femur, 78 μ; tibia, 69 μ; tarsus, 60 μ; claw, 21 μ.

The margin of the body bears a continuous row of rather short spines, truncate at the apex, and measuring a maximum of 18 μ in length. Thoracic incisions (Plate 1, fig. 2, *b*) normally with four spines, which are slightly longer than the marginal ones, the apex of these spines being blunt as in the adult. About ten small circular pores occur between the spiracles and the body margin. The anal plates are similar to those of the adult female in general shape, with a distinct apical spine. The anal ring bears eight hairs.

The first-stage larva, male.—Similar to that of the female, but somewhat broader (Plate 2, fig. 3). Legs and antennæ stouter, the latter 6-jointed (Plate 1, fig. 3, *a*). Marginal spines (Plate 1, fig. 3,*b*) as in the female, but those of the thoracic incisions fine hairs (Plate 1, fig. 3, *c*) instead of blunt spines.

The second-stage larva, male.—General shape broadly oval (Plate 2, figs. 5, 6, 7, 8), widening in the abdominal region. Antennæ and legs small and weak. Antennæ 7- instead of 6-jointed [5] (Plate 1, fig. 4, *a*) as in the female.

The measurements of the different joints are as follows:

Joint.				
	μ.	μ.	μ.	μ.
Second	18	21	21	21
Third	33	33	30	33
Fourth	15	18	21	20
Fifth	21	21	21	29
Sixth	21	21	21	21
Seventh	39	33	36	37

The body margin with fine hairs, much fewer than in the preceding stage. The thoracic incisions with two sharp spiny hairs (Plate 1, fig. 4, *b*), and the dorsal surface with numerous small pores. Other characters are similar to those of the female.

Immediately before [6] the second molt the body becomes plump,

[5] Sasaki(17) states that the antennæ at this stage consist of three joints only.

[6] The third stage of Sasaki(17) is really the second-stage larva just before the molt. Fig. 10 of Yano(20) appears to me to be also the second-stage larva just before the molt, rather than the third.

glassy, and pale yellow, and is completely covered with the white wax.

The propupa, male.—Following the second molt the male larva assumes the form of a partly developed pupa, called the propupa. The form is oval, with the abdominal region broadest and distinctly segmented (Plate 2, figs. 9, 10). Length, 2.11 millimeters; width, 1.10. The head and thorax are pale orange yellow; the eyes are reddish orange. The posterior end of the body is slightly darker. The antennæ are short, reaching to the base of the anterior legs, and the segmentation is indistinct. Wing pads short, curving a little toward the underside of the body, the apex reaching to the second abdominal segment. Anterior legs very short, reaching to the suture between the thorax and the head, while the two posterior pairs lie against the abdomen. Mouth parts wanting.

The pupa, male.—With the third molt the male becomes a true pupa (Plate 2, figs. 11, 12), greatly resembling the adult male except for the lack of the waxy anal filaments and the possession of wing pads instead of wings. The general color is pale orange with dark purple eye spots, the margins of these being indistinct; antennæ, legs, and wing pads somewhat paler. Antennæ indistinctly 10-jointed and long, reaching to the base of the middle pair of legs. The wing pads are appressed to the sides of the body and extend posteriorly to the second abdominal segment. Legs slender, the anterior pair extending beyond the head, and the posterior pair to near the tip of the abdomen. Mouth parts wanting. Length, 2.49 millimeters; width, 1.08.

LIFE HISTORY AND HABITS

About the end of August the insect is very conspicuous on the branches of *Fraxinus bungeana* var. *pubinervis* growing along the footpaths between the rice fields about Tokyo City; it is particularly noticeable at this time because of the white waxy mass formed by the males (Plate 2, fig. 13). The fully matured female is a large globular object (Plate 2, fig. 2) and firmly attached to the branch, but its color is not striking.

There is but one generation a year. The first female larvæ appear about June 15 from eggs laid some two months previously beneath the mother, where they are hidden from view. The eggs are elongate-oval and somewhat deeper in color than those which produce males. Usually the young remain under the protection of the parent scale for a few days after hatching. The newly hatched young is soft and feeble, but becomes hard

and active when ready to crawl out from beneath the shell of the mother. The larvæ become very active soon after emergence and begin searching for a suitable place at which to feed. All immediately crawl upward onto the leaves where they become attached on the upper surface (Plate 2, fig. 1, *a*). They settle along the veins and do not congregate in groups. As feeding commences there is a noticeable increase in size, and within a few days the dorsal surface becomes covered with a white woolly substance. At the end of the first stage the larva molts, the cast skin being pushed backward off the tip of the abdomen. About a month is required to complete the first stage.

The first molt occurs about the middle of July, after which the insects descend to the naked branches, the majority of them settling on the freshly grown twigs, but some also on branches two or three years old. The insects remain in this stage until about the latter part of August or early September, and after the second molt takes place the adult stage is reached. The female is a sessile object with the dorsum somewhat extended into a cone and flattened ventrally, and the color is greenish yellow with close grayish bands on the thoracic surface. Diameter, about 1.5 millimeters. The antennæ are 6-jointed, as in the previous stages.

A few days after the female larvæ have emerged, the young males come out from beneath the mother, these having hatched from the eggs of lighter color. The male larvæ crawl upward to the leaves and settle in clusters on the undersurfaces (Plate 2, fig. 1, *b*), thus differing in habit from the females. The antennæ of the male consist of six joints, as in the female. Within two days the body is covered with a white woolly secretion.

The first molt takes place about the same time as that of the female or possibly a few days previously, the larvæ then descending to the 2- or 3-year-old twigs and settling on the underside (Plate 2, fig. 1, *c*), then commencing immediately the deposition of wax. Within two or three days the dorsal surface of the mass of insects is nearly concealed by this wax, and about ten days later the bodies are completely embedded in a thick mass of the substance. The thickness of this wax is about 6 to 7 millimeters. The deposit is always heaviest on the underside of the branch, but often extends entirely around it. Before the second molt the body becomes very plump and stands at right angles to the branch, being attached thereto by the mouth parts.

The second molt having taken place, the larva is transformed to a propupa. The male from now on is without mouth parts, and during the dormant period is an inactive creature, able only to move its front legs feebly and to wriggle the abdomen when disturbed. After four or five days the third molt takes place and the pupa appears, this greatly resembling the adult male. As in the preceding stage, it is inactive. About the same length of time is required for this stage as for the preceding one.

When the pupal skin is cast the wings of the male are extended to their full length and then folded, one over the other, upon its back. As soon as the wax filaments have grown to their full length, which requires one or two days, the male backs out of the cocoon, or wax case, and becomes active. It immediately begins searching for a female with which to mate. The life of the adult male is very short, and death occurs soon after mating.

After mating the body of the female increases gradually in size, but not very noticeably until the winter is over. In January of the following year the diameter is about 4 millimeters, and in March the dorsal surface becomes much developed in a hemispherical form and about 6 to 8 millimeters in diameter. The color becomes dark reddish brown with black spots. In the middle of April the deposition of eggs is begun. In early May the body becomes globular and *Kermes*-like in appearance and brownish in color. At this time oviposition is completed and the heavily chitinized skin is nothing but a protecting shell over the eggs.

Each female is capable of laying a great number of eggs, the greatest number under a single female recorded by me being 15,028 and the smallest, 3,372. The egg stage is rather long, the eggs laid in the latter part of April beginning to hatch about the middle of June; that is to say, the incubation period requires about two months.

The proportion of male and female young was not well determined, but in one instance I isolated 1,000 eggs from a single female and kept them in a glass jar for rearing. In this series the proportion was 355 females to 645 males.

FOOD PLANTS

The following plants are recorded as hosts of *Ericerus pela* in Japan:

Chionanthus retusens L. and P. (Hitotsubatago.)
Fraxinus bungeana DC. var. *pubinervis* Wg. (Toneriko.)
Fraxinus longicuspis S. and Z. (Koba no toneriko.)

Ligustrum ibota Sub. (Ibota.)
Ligustrum japonicum Thunb. (Nezumimochi.)
Ligustrum medium F. and S. (Obaibota.)

It appears to me that *Ligustrum ibota* and *Fraxinus bungeana* var. *pubinervis* are the two plants on which the scale is commonly found about Tokyo, and commercial wax production is principally obtained upon the last-named plant. In Kiushu, however, I found it upon *Ligustrum japonicum*. In China(19) the scale is cultivated on *Ligustrum lucidum* Sit. and on *Fraxinus chinensis*. I collected the scale upon the former in a park at Shanghai which I visited en route to Japan after a trip to the South Sea Islands and India in 1921.

NATURAL ENEMIES

According to Sasaki(17) there is an encyrtid parasite (*Encyrtus* sp.) that attacks the scale, and Yano(20) states that *Brachytarsus niveovariegatus* Roelofs attacks the female scale heavily, while *Chilocorus similis* Rossi and *C. tristis* Fold. often attack the larvæ. He also mentions a species of Cecidomyidæ bred from the female scale. Unfortunately, I have not had the opportunity to study the natural enemies of this scale.

ECONOMIC IMPORTANCE OF THE WAX PRODUCT

Ericerus pela is not cultivated in Japan for the purpose of wax production, although the scale develops freely on *Ligustrum ibota, Fraxinus bungeana* var. *pubinervis,* and other plants in the wild state, and peasants often collect the wax in the autumn for the market. The raw wax product is sold in drug stores under the name of *ibota-ro* and is commonly employed as a polish on furniture and other woodwork.

In western China, however, the production of insect white wax has been a most important industry for centuries. About the end of August the white coating is scraped from the branches of *Fraxinus chinensis* and *Ligustrum lucidum* and thrown into boiling water, in which the wax melts and floats to the surface. It is collected by being skimmed off, and while in a plastic state is molded into thick saucerlike cakes. The wax is colorless and inodorous, tasteless, brittle, and readily pulverizes at 60° F. It is slightly soluble in alcohol and dissolves with great facility in naphtha, out of which fluid it may be crystallized. It melts at about 180° F., is lighter than water, and is said to harden by long immersion in cold water. This insect white wax is largely used in the manufacture of candles and in paper glazing, but it is also used in medicine shops as a coating for pills, and is itself

supposed to possess medicinal properties. It is also employed as a polish for furniture, etc. According to Wilson(19) the annual output varies considerably, the industry being almost entirely dependent upon climatic conditions. In poor seasons 50,000 piculs is an average crop, whereas in favorable years more than double this quantity is produced. In spite of the increased consumption of foreign candles and kerosene oils the demand for insect white wax remains steady, and the industry concerned with its production shows very few signs of decline. Owing chiefly to difficulties in navigation on the Yangtsze and consequent heavy freight charges, foreign goods are very expensive and enjoyed only by the wealthy. With the advent of railways vast changes will certainly take place, and this interesting insect-wax industry may at some future date become extinct.

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ILLUSTRATIONS

PLATE 1.

FIG. 1. *Ericerus pela*, adult female; *a*, antenna; *b*, part of hind leg; *c*, spiracular and marginal spines; *d*, anal plates, left from above, right from lower.

2. *Ericerus pela*, second larval stage, female; *a*, antenna; *b*, spiracular and marginal spines.

3. *Ericerus pela*, first larval stage, male; *a*, antenna; *b*, spiracular and marginal spines; *c*, posterior apex of abdomen, showing anal plates and marginal hairs.

4. *Ericerus pela*, second larval stage, male; *a*, antenna; *b*, spiracular and marginal spines.

PLATE 2. ERICERUS PELA CHAVANNES

[All figures except 1, 2, and 13 are greatly magnified.]

FIG. 1. Branch of *Ligustrum* with young larvæ; about natural size. *a*, newly hatched larvæ, female; *b*, newly hatched larvæ, male; *c*, second stage larvæ, male.

2. Branch of *Fraxinus bungeana* var. *pubinervis* with adult females; about natural size.

3. Male, first larval stage.

4. Female, first larval stage.

5. Male, second larval stage, dorsal view.

6. Male, second larval stage, ventral view.

7. Male, second larval stage, lateral view.

8. Second stage larva of male, just before molt.

9. Propupa, dorsal view.

10. Propupa, ventral view.

11. Pupa, dorsal view.

12. Pupa, ventral view.

13. Group of cocoons with white wax; natural size.

14. Adult female in winter, dorsal view.

15. Adult female in winter, ventral view.

16. Adult female in winter, lateral view.

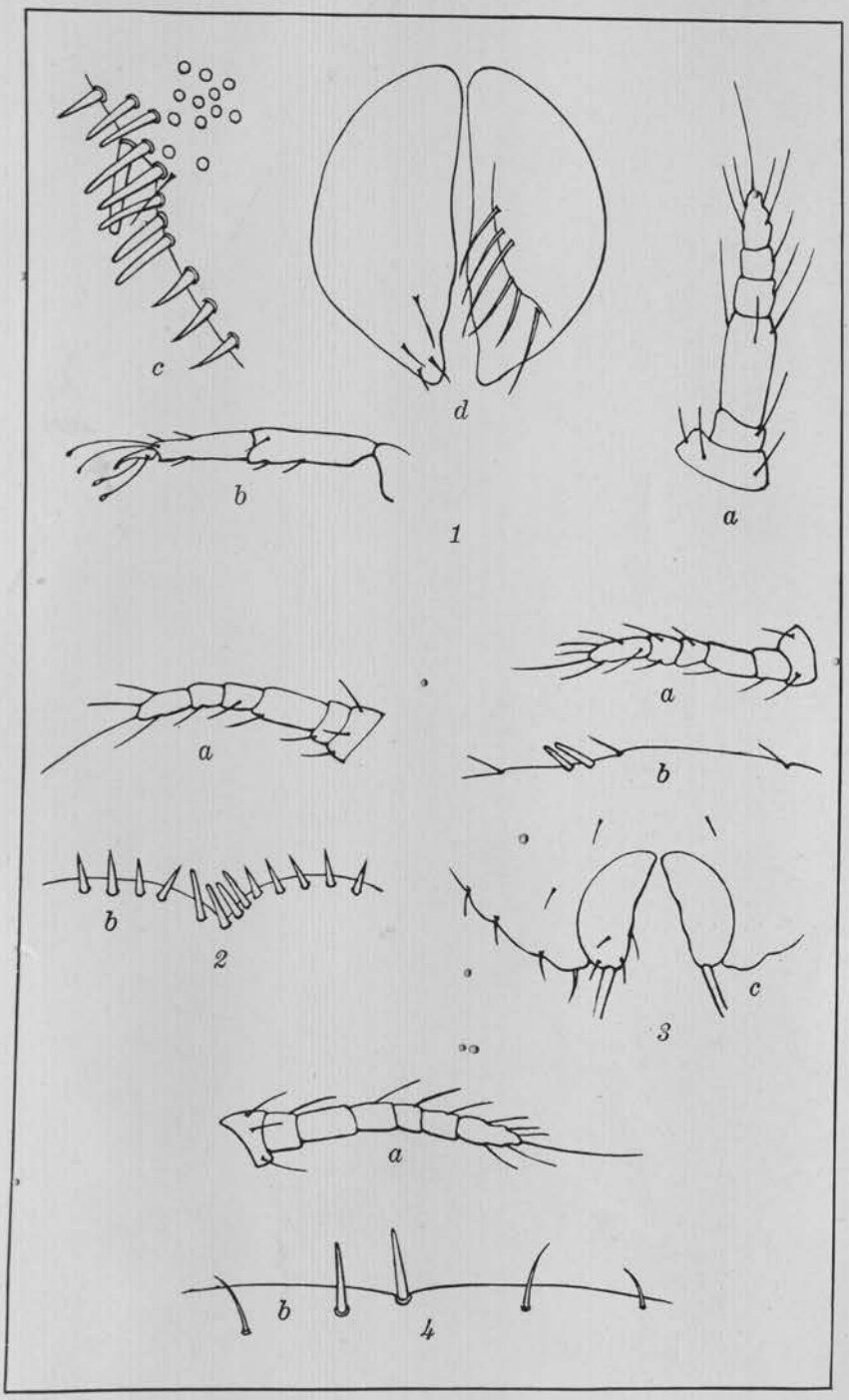

PLATE 1.

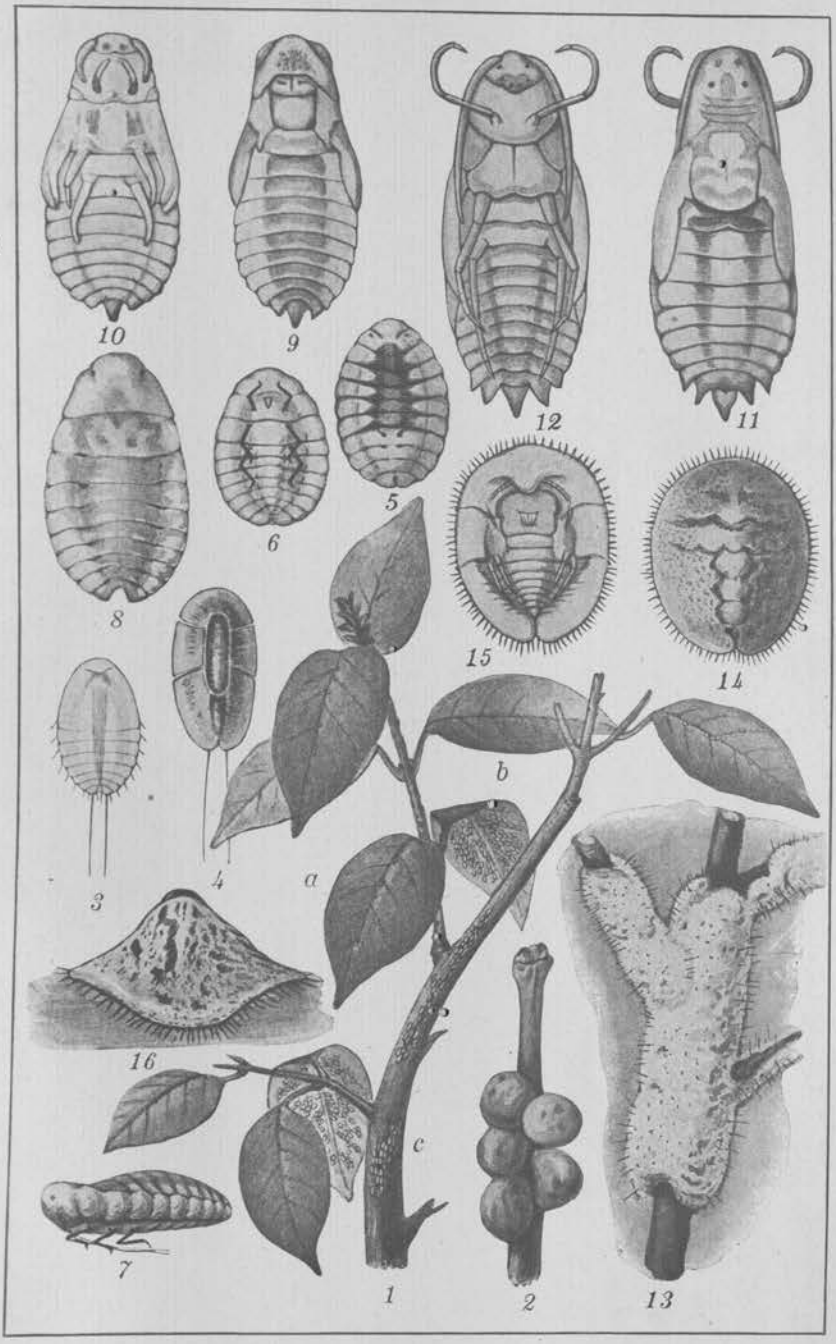

PLATE 2.

A METHOD OF ILLUSTRATING INSECT WINGS

By CHARLES S. BANKS

Of the Bureau of Science, Manila

ONE PLATE

In the preparaton of articles dealing with insect taxonomy, the delineation of insect wings often becomes a serious problem to the entomologist who lacks skill in draftsmanship or does not have available the services of a trained artist. This becomes a decided handicap or a real menace to accuracy in certain orders and families where venation is complicated and where so much depends, especially in generic characterizations, upon minute differences in size or direction of certain veins.

While inked camera lucida tracings are very satisfactory for those wings small enough to come within the field of the microscope, their preparation imposes to too great an extent upon the patience and steadiness of the one making them. In the case of larger wings, the shifting of the specimen and the making of tracings in sections to be united afterwards not only cost time and much labor but also are not infrequently causes of grave errors not at the time perceived by the worker.

Recourse may be had, in many cases, to photography in its ordinary phases and this, supplemented by photomicrography, naturally gives the most-accurate and pleasing results.

It was in casting about for a simplification of the photographic process that it occurred to me to try another method of reproduction, one which has been used with effect for other objects. This was to make a contact negative of the specimen the reproduction of which was desired, and from this negative to make a series of bromide enlargements of any convenient size.

The process by which these reproductions are made requires first that the wing be removed from the insect. It is then laid out, with others which it is desired to reproduce, upon a piece of glass, 12.5 by 20 centimeters (5 by 8 inches), preferably a flawless photographic plate from which the negative emulsion has been removed. After being properly arranged the wing base is touched with a drop of thick white shellac which, when it

produced in the same way, provided they be not so small that the photographic emulsion fails to get outline or detail.

Of course the artist will spurn this quick method of reproduction; but, as opposed to many of the painful attempts of some of our entomolgists who do not possess the divine gift, it will be found that this method is calculated to give infinitely more pleasure to those who must look at the finished work.

In the accompanying plate specimens are shown from the most delicately transparent to the most opaque wings obtainable and yet all, except perhaps fig. 10, give practically all the venation details necessary for taxonomic purposes. It will be noted that none of the figures has been retouched in the least.

This method can be and undoubtedly has been applied to the making of prints from such objects as skeletonized leaves, thin rock sections, bone sections, handwriting, and manufactured articles such as laces, woven fabrics, etc.

191652—5

ILLUSTRATION

PLATE 1. Wings of Tipulidæ taken at random, to show ease of reproduction in specimens from the most transparent to the most opaque. These were all made on the same plate at the same time, and neither the negative nor the print has been retouched.

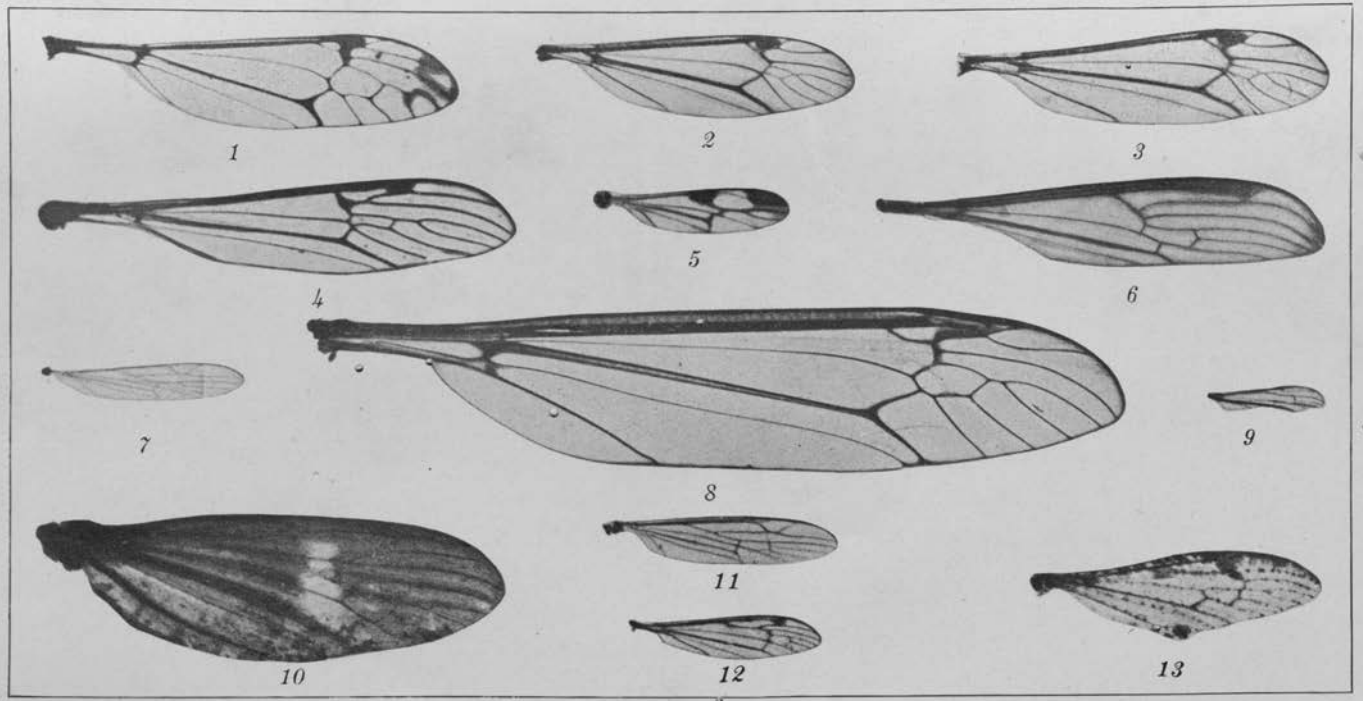

PLATE 1. WINGS OF TIPULIDÆ, TO SHOW REPRODUCTION.

HISTOPATHOLOGY OF THE INTESTINE IN CHOLERA

By ERNEST W. GOODPASTURE

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ONE PLATE

The final diagnosis of cholera rests upon the demonstration of agglutinable vibrios; nevertheless, during an epidemic the pathologist can recognize the disease post mortem in the majority of cases by gross anatomical appearances, although no distinctive single lesion has yet been described. The diagnosis is arrived at by weighing the evidence of a group of changes which are commonly found in typical instances. Crowell(1) has summarized these features as follows: An acute catarrhal enteritis associated with cyanotic finger nails, dry tissues, oligæmia; dry and sticky peritoneum with pink serosa of ileum; contracted and empty urinary bladder; shrunken, dry spleen and liver; acute degeneration of parenchymatous organs; poorly coagulated blood; absence of formed fæces; presence of rice-water intestinal content; and prominence of lymphoid tissue in the ileum.

The mucous membrane of the small intestine presents no characteristic anatomical change but varies in appearance depending on the course of the disease. It is described by Koch(4) as showing in different necropsies all transitions, from a moderate swelling and clouding of the superficial layers and rose red color to a more intense swelling and reddening with extensive loss of epithelium and, finally, to a blue-black discoloration, numerous hæmorrhages, superficial necroses, and even diphtheritic changes.

In a recent small outbreak of cholera in Manila all these variations in appearance of the intestine were encountered at necropsy and an equal diversity in the character of intestinal content, varying from a relatively small amount of greenish, bile-stained, mucus-containing fluid to a voluminous, purplish, blood-stained, watery material with mucus and desquamated epithelium in suspension. In some instances as much as 2 liters of fluid was present in the bowel. The wall of the small intes-

tine, especially the duodenum and jejunum, seemed lax and flaccid, often considerably distended by fluid, suggesting the appearance in paralytic ileus.

This condition of the intestine obviously makes more difficult the problem of securing material suitable for histological study, for the mucosa of a normal intestine rapidly undergoes post-mortem changes, so that the ordinary necropsy specimen is unsatisfactory for histological purposes.

To this difficulty in securing suitable fresh material are due undoubtedly our lack of an adequate description of the histopathology of the intestine in cholera and the differences of opinion on certain points such as whether desquamation of epithelium occurs to any extent before death, as maintained by Deyke,(2) or whether denuding of the mucosa, which everyone describes, is a result of post-mortem maceration, a view advocated by Cohnheim and others.

A complete knowledge of the histopathology of the intestine in early stages would probably throw some light on the obscure pathogenesis of cholera, which appears to be different in principle from any other acute infectious disease. The nature of the intoxicating substance is still in question, and it is yet to be determined whether the intestinal manifestations are due directly to injurious action of a poisonous substance on the mucosa or whether the intestinal congestion, excretion, and anatomical changes are manifestations of the general intoxication. Of special interest is the question of possible desquamation or extensive injury of epithelium which may permit a rapid absorption of toxic material from the intestinal contents.

In a series of cases from San Lazaro Hospital, Manila, which I recently had an opportunity to study, special care was taken in examinations of the intestine. From twenty-five necropsies performed after various intervals it was soon evident that no very reliable information could be gained from material obtained as long as two hours after death. In some instances it was possible to remove the intestine and fix portions of it in less than one hour after death. In one early case on opening the peritoneal cavity slow contractions of the small intestine could be elicited by mechanical stimulation. Such material was very well preserved and its histopathology is worthy of description.

The earliest case was a female Filipino child that was admitted to San Lazaro Hospital at 11.45 a. m., January 12, 1922, and died at 2.10 p. m., January 13. Duration of illness on admission three days. Condition on admission very weak and

drowsy, with abdominal pain and loose bowel movements. Illness began suddenly with loose black discharge. Much vomiting since onset and patient refused to take anything by mouth. Even water could not be tolerated. Child was quiet but apparently conscious. Eyes slightly sunken, face pale, tongue coated, pulse rapid, feeble, thready, and barely perceptible. Extremities cold but not cyanotic. Urinated only twice since onset. Temperature on admission, 36.9° C.; twelve hours later, 36°. Pulse, 85; twelve hours later, 144. Respiration, 23; twelve hours later, 31. Although treatment was immediately instituted the child did not respond well and died twenty-six hours after admission, or four days after the onset.

At autopsy the small intestine was faintly pink. It contained about 100 cubic centimeters of fluid with much mucus stained green with bile. The mucosa appeared velvety and pale. Portions of stomach, duodenum, jejunum, ileum, and colon were immediately placed in formol-Zenker. There was infection with ascaris and with trichuris. Clinically and pathologically it was a typical case of cholera, and cultures from intestinal contents showed the presence of agglutinable vibrios.

Blocks from the gastrointestinal tract were embedded in paraffin and sections stained with hæmatoxylin and eosin and by the fuchsin method for bacteria.(3)

Mucous membrane of the stomach appears normal. Fixation is excellent and there is no evidence of degenerative change even of the superficial cells. The mucosa of the colon shows no lesions except those due to the threading of trichuris through superficial layers in the cæcum. There is, however, a definite pathological change throughout the small intestine, increasing in severity from the duodenum downward.

The mucosa of the duodenum is intact and well preserved, although there is a great subepithelial œdema which has lifted up the epithelial layer, completely separating it from the mucosa except for a delicate honeycomb of lines which seem to represent a continuation of the outline of each cell. The basement membrane remains attached to the mucosa, the fluid apparently accumulating just beneath the cellular body pushing it upward from its basal attachment. The effect of this œdema has been to increase the length of villi by about one-half and the width of the mucosa about one-third. The epithelial layer is intact everywhere except on the crests of valvulæ conniventes where it is broken in places, evidently in the process of preparation, for often the detached layer of cells remains close by. The epi-

thelial cells show no obvious degenerative change; the striated cuticular border is well preserved, the cytoplasm and nucleus compact, staining normally. The number of goblet cells is perhaps increased. Mitotic figures are frequent but not more conspicuous than in a normal intestine.

The mucosa is swollen, especially its papillary projections into villi where intercellular spaces are globular in shape and much exaggerated in size. There is a moderate congestion of capillaries in villi and to a lesser extent of veins in the mucosa and submucosa elsewhere. Larger lymphatics are also prominent and filled with the granular precipitate of a lymph probably of high protein content. No hæmorrhage or cellular exudate is to be seen. There is, however, a very peculiar necrosis of cells within and upon the tips of villous projections of mucosa. This is to be found in nearly every villus and is more prominent in the ileum than in the duodenum and the jejunum. It appears as a karyorrhexis of one or more nuclei of uncertain type, sometimes free, often within large phagocytic cells which may plug capillaries at the apex of villi. This necrosis is sometimes seen along the side of a villus but is found with striking uniformity in the tips. An occasional polymorphonuclear or mononuclear leucocyte is caught wandering through a villus, and usually there are a few small mononuclear cells within the subepithelial spaces. At no point is there necrosis of all cells, and capillary endothelium is intact. The cells that become necrotic appear to lie between capillaries and under or upon the basement membrane of epithelium.

The condition of jejunal mucosa is about the same as that of the duodenal. In the ileum desquamation of epithelium is much more prominent, especially in the lower portions. However, in places where the epithelial layer is still well preserved, subepithelial œdema is present, elevating the cells considerably above the basement membrane but to a less extent than in the duodenum or the jejunum. It is to be noted also that villi denuded of their epithelium differ in no way otherwise from those over which an epithelial coat is still present. There is no more congestion of capillaries, interstitial œdema or necrosis, a fact which appears incompatible with the view that desquamation occurred earlier than the agonal state. The apical necrosis in villi is more prominent than in upper portions of the bowel, and phagocytosis of dead cells is more active. Lymphoid follicles in the submucosa are compact, and show neither necrosis nor abnormal proliferative activity.

In sections stained for bacteria no vibrios could be demonstrated in the duodenum or the jejunum. No organisms of any kind were seen within glandular crypts or beneath the epithelium. In the ileum, on the other hand, especially in the lower portion, an abundant surface growth of various types of bacteria was present and many of these organisms had penetrated the mucosa to a certain extent beneath the elevated epithelium and within denuded villi. They had, however, apparently caused no injury or reaction. Glandular crypts were often filled with bacilli of unrecognized type. In the abundant surface growth of bacilli, cocci, and filamentous forms, no vibrios were identified. Vibrios of unmistakable morphology were found only in glandular crypts, where they lay in great numbers embedded in a film secretion, and often apparently in pure culture. The epithelium immediately around these organisms showed no indication of injury as a result of their presence, and the vibrios exhibited no tendency to invade the tissues.

The most-striking change observable in these preparations in well-preserved portions of the intestine was the subepithelial œdema, which was undoubtedly responsible indirectly for the widespread desquamation of epithelium.

A second case, that of an adult male Japanese, autopsied within two hours after death, shows early post-mortem changes in the epithelial layer and in contrast to them the beginning of antemortem ulceration.

The patient, a man aged 45 years, was admitted to the hospital on the second day of the disease complaining of cramps in the lower extremities, chest oppression, hardly perceptible pulse, and husky voice. Clinically he had cholera, and the bacteriological examination of his stool showed agglutinable vibrios. He developed uræmia and died on the ninth day of the disease.

At autopsy he was found to have very large congenital cystic kidneys, which microscopically showed foci of necrosis involving cortical parenchyma. The small intestine was congested, and the mucosa showed in gross no evidence of ulceration. Pieces were placed immediately in formol-Zenker.

Microscopically, sections through the ileum show the usual subepithelial œdema with as yet very little desquamation. The epithelial layer is partially well preserved, but in many places, especially at the crests of villi, post-mortem changes are very evident, both in the epithelium and in the tips of villous projec-

tions. There are karyolysis and faintly staining cytoplasm, although the outlines of cells are in position. In places where the process of disintegration is more advanced, there are complete disappearance of nuclei and dissolution and softening of epithelium with dislodgment of fragments, leaving the tips of villi denuded; but there is no inflammatory reaction in these places. Overlying such areas is an abundant growth of bacilli, giving the impression that they are partially responsible for this rapid disintegration; rarely, however, are they found within subepithelial spaces, and then only where epithelium has disappeared at some point.

In contrast to this evident post-mortem disintegration there are minute areas of ulceration, obviously ante mortem, for there is necrosis of epithelium, fibrin thrombi in capillaries and veins, as well as polymorphonuclear and epithelioid cell infiltration. In the superficial necrosis there is a sharply limited zone of bacilli having the morphology of *Bacillus coli*, and these bacilli are evidently responsible for the lesion. In the preparations no vibrios are demonstrable on the surface, in the lesions, or within glandular crypts. Had this intestine been examined an hour or so later there would undoubtedly have been extensive desquamation and the areas of ulceration could easily have been overlooked. Agglutinable vibrios were demonstrated in cultures post mortem.

It seems almost too obvious for further consideration that, if ulceration occur in cholera before the agonal period, an inflammatory reaction will appear which can be easily identified. Yet a third case in this series, autopsied one hour and fifteen minutes after death, showed even more strikingly evidences of ante-mortem necrosis of epithelium and ulceration due certainly in part to the local action of vibrios.

This case also was an adult Japanese. The patient, a male, aged 28 years, was admitted to the hospital three hours after the onset of illness. He was in complete collapse, pulse hardly perceptible, extremities cold, with clammy perspiration and cramps. Bowels had moved twice; stools watery in character. The diagnosis, clinically and bacteriologically, was cholera. He died on the sixth day of illness, showing toward the end indications of uræmia. On opening the peritoneal cavity one hour and fifteen minutes after death the upper portion of the small intestine was found to be tremendously distended with gas and

fluid. The duodenum and jejunum measured 6 centimeters in diameter. There was no free fluid in the peritoneal cavity. Loops of jejunum and upper ileum were bound together by thin fibrinous adhesions. In the wall of the jejunum and extending about halfway down the ileum were several large areas of opaque yellowish and greenish necrosis which tended to extend circularly around the gut. The necrosis was most marked opposite the mesenteric attachment. No perforation had occurred, but fibrino-purulent exudate was abundant in the regions of necrosis. The intestinal wall was œdematous, injected, and contained numerous small hæmorrhages. The lower end of the ileum was about normal in size. There was no evidence of mechanical obstruction. The stomach was considerably dilated, especially by gas. No necroses were observed in its wall.

Anatomical diagnosis: Acute enteritis (cholera); dynamic ileus; necrosis of jejunal and iliac walls; acute peritonitis; parenchymatous degeneration of kidneys, liver, and heart.

Microscopically, sections from the upper part of the small intestine show necrosis of the wall and ulceration of mucosa. The submucosa generally is extremely œdematous, and rugæ and villi are flattened because of excessive dilatation. Beyond areas of ulceration the epithelium is well preserved and shows no post-mortem change or desquamation. There is an abundant coating of mucus and there are fragments of necrotic mucosa over the surface, especially between folds. Over the peritoneal surface is a thin fibrinous membrane. In areas of ulceration there is superficial necrosis, polymorphonuclear leucocytic exudate, intercellular fibrin, thrombosis of some small vessels, and congestion of others. In stained sections enormous numbers of bacteria of various types are found in the mucous coat and on the surface of ulcerated areas. The majority of these are short, easily stained bacilli, and thin filamentous forms. In some places, however, masses of smaller, less intensely staining, curved rods are present, morphologically identical with cholera vibrios. The various organisms occur in dense groups so that one type may be easily distinguished from another. No bacteria are found in glandular crypts or invading the mucosa except at the site of ulceration. On the surface of ulcers and for a certain distance within the inflammatory exudate are small curved vibrios, apparently in pure culture. The morphology of these organisms is so distinct that there can be little doubt they are vibrios of cholera.

DISCUSSION

Until the relation of vibrios to the inflammatory process in the third case was observed, it seemed to me very doubtful that vibrios of cholera were ever directly responsible for intestinal ulceration. Evidently they are capable of invading tissue locally and inciting an acute inflammatory process with polymorphonuclear leucocytic exudate. This fact is of importance for understanding the pathology of the intestine in cholera and is suggestive with respect to the pathogenesis of the disease. Since cholera vibrios are capable of tissue invasion and the production of ulceration and inflammatory exudate, it seems obvious that, if desquamation of epithelium occurred to any extent ante mortem, the pathology of the intestine would be very different from what it is found to be, unless desquamation is always followed by immediate death before inflammatory reaction can occur. We would expect to find an acute ulcerative enteritis the typical lesion, but this is the exception, and practically always late in the disease after reaction has begun. The finding of desquamated epithelium in cholera stools means ulceration of the mucosa if the patient survives.

The evidence at hand indicates that it is the growth of vibrios within the lumen of the small intestine that is directly or indirectly responsible for the production of intoxication, and if toxic substances are formed in the intestine they are at first absorbed through a mucour membrane which is anatomically intact except for œdema.

Whether the constant subepithelial œdema is caused by direct action of injurious intestinal material or is a result of splanchnic congestion associated with general intoxication is an open question. Experimental evidence shows the possibility that the latter may be the correct explanation.

Toxic protein products, such as those derived from closed duodenal loops in experimental intestinal obstruction in dogs, when injected intravenously into dogs cause a profound splanchnic congestion, especially of the upper portions of the small intestine, associated with a rapid excretion of intestinal fluid. Histologically, the congested intestinal mucosa shows a similar accumulation of fluid beneath the epithelial layer which becomes elevated, especially over the villi, to a degree equal to that found in the intestine of cholera, and this change is also most marked in the duodenum and the jejunum. The presence of fluid here represents apparently a phase in the great excretory activity of the intestine. The necrosis of a few cells at the tips of the

The habitat of vibrios in most cases of cholera is within the intestinal lumen; and, while a few organisms may survive entrance into the blood stream, most of them are no doubt rapidly destroyed. Judging from post-mortem appearances of the intestine, where evidences of their pathogenic nature should be most prominent, the symptoms of cholera are induced by the production, within the lumen of the small bowel, of material which is absorbed through a non-ulcerated mucosa, manifesting its poisonous character by a general intoxication. The œdema of the intestinal wall seems to be a part of the systemic reaction, with splanchnic dilatation, and excretion of quantities of fluid. Finally, there is no indubitable anatomical evidence that in cholera there are changes in the intestinal mucous membrane which would render it more permeable than the normal intestine.

SUMMARY

1. There is a constant subepithelial œdema in the small intestine of cholera subjects, which may be due to splanchnic congestion associated with general intoxication rather than to direct injury of toxic material within the lumen.

2. Desquamation of epithelium in the small intestine as seen at necropsy is an agonal or post-mortem effect due to the action of bacteria and, possibly, of enzymes of intestinal fluid upon the epithelial layer displaced during life by œdema.

3. Ante-mortem desquamation may occur but can be recognized at necropsy by the presence of ulcers with acute inflammatory exudate.

4. The vibrios of cholera may invade the mucosa and be directly responsible for an acute ulcerative enteritis, but they are not always the cause of intestinal ulcers complicating the disease.

5. Anatomical evidence indicates that the great mass of vibrios is confined to the intestinal lumen and, if toxic substances are formed there directly or indirectly as a result of their growth, they are absorbed early in the disease through an anatomically intact mucosa.

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ILLUSTRATION

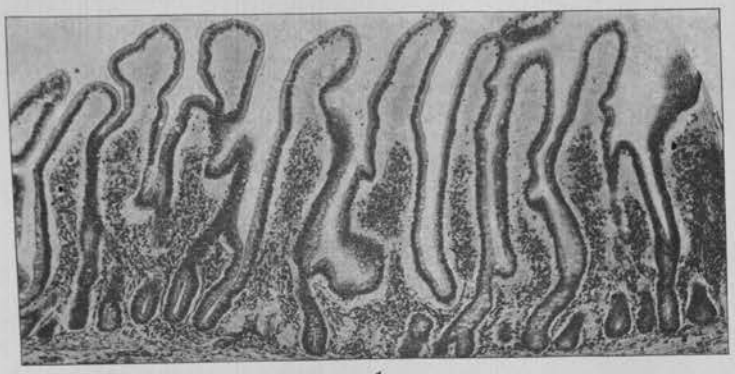
PLATE 1. THE INTESTINE IN CHOLERA

FIG. 1. Section of jejunum from case 1, forty-five minutes post mortem, showing subepithelial œdema, but well-preserved epithelial layer.

2. Section from ileum, case 2, showing subepithelial œdema and beginning post-mortem maceration. Note absence of nuclei at tips of villi and rupture of epithelial layer.

3. More-advanced maceration in case 2.

4. An area in jejunal ulcer in case 3, showing polymorphonuclear leucocytic exudate and vibrios.



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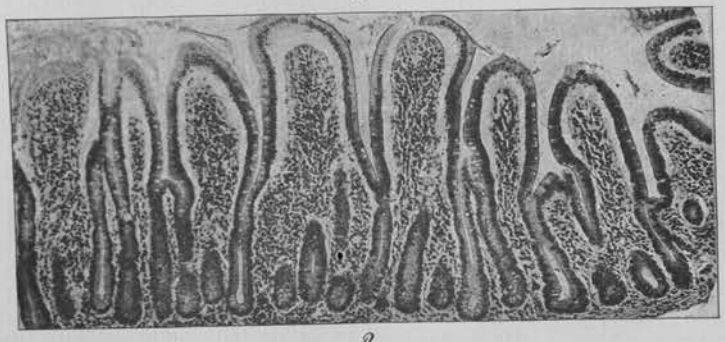

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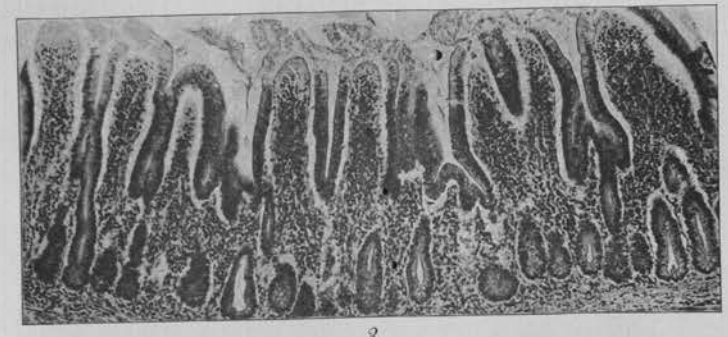

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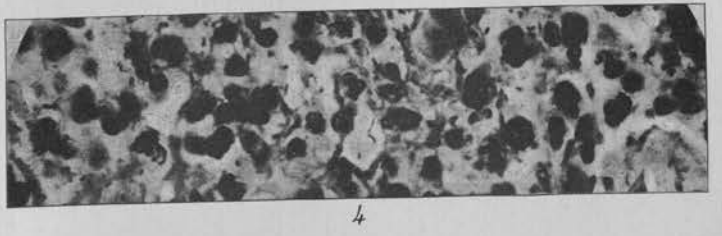

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PLATE 1.

COMPLEMENT FIXATION IN TREATED AND UNTREATED LEPROSY

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Recently the Philippine Health Service has decreased the period of compulsory detention of lepers to six months after they have become bacteriologically negative; discharged lepers are required to report for observation and treatment periodically. The reduction of the detention period from two years to six months has been made, not on the assumption that these sufferers from leprosy have been cured, but from a belief that they are no longer a menace to the community, and in the hope that, with less-rigid restriction, cases will present themselves earlier for treatment. Even with the great hope held out by the results of treatment with chaulmoogra oil such changes in policy must at the present time be tentative and must be dictated by considerations of expediency, because there do not exist to-day means of determining either that a complete cure has been effected or what extent of improvement is necessary before a leper can be considered as no longer a source of infection.

Undoubtedly, in chaulmoogra oil and its products a most-promising means of combating leprosy on a large scale is at hand. This fact makes more apparent than ever the lack of methods for controlling its use and for more accurately individualizing treatment, without which the success of therapy, especially on such a scale as now practiced at the Culion Leper Colony, will be greatly hampered. Evidences of clinical improvement and the disappearance of demonstrable acid-fast bacilli from accessible parts are of utmost importance, but it is evident that more definite and measurable data are desirable; and improvements in therapy must be accompanied by laboratory investigations to establish methods for proper control, so that the largest measure of success may be attained.

In the present paper observations are presented which, though incomplete and on too small a scale to be final, at least indicate definitely the possibility of utilizing immunological methods

helpfully in conjunction with clinical and bacteriological means in arriving at a more-accurate knowledge of the effect of treatment in individual cases.

Investigations have been conducted with a view of observing the effect of treatment with chaulmoogra oil and its products on complement-fixation reactions with serum of lepers, using various antigens, and the results may be described in two groups; namely, those with lipoidal antigens and those with bacterial suspensions.

WASSERMANN REACTION IN LEPROSY

It has been known for some years that positive Wassermann reaction is obtained in a considerable proportion of cases of leprosy, and that the percentage is higher in the nodular type than in the anæsthetic. Recently Cooke(2) has carefully tabulated the reported cases, 1,397 in all at the time of his publication, including both types. In 50 per cent of these positive reaction was obtained. Seven hundred twenty-three cases were reported to be of the nodular and mixed variety, and in this group 60 per cent were positive; 405 were purely anæsthetic cases, and only 25 per cent of these gave positive reaction.

The presence of positive Wassermann reaction in leprosy cannot be attributed to coincident syphilitic infection, as has been sufficiently proven by unselected groups of controls, as well as on clinical and therapeutic evidence.

METHOD

The Wassermann test was performed according to the details described by Hinton.(4) In the hæmolytic system 2 units of antisheep amboceptor, 0.5 cubic centimeter of a 5 per cent suspension of washed sheep cells, brought to the original volume of whole blood, and 2 units of guinea-pig serum complement were used in each test. The uniformity of sheep-cell suspension was controlled by a color standard, and sera from several pigs were pooled to obtain a complement of uniform strength. A maximum of 0.1 cubic centimeter of patient's heated serum was used in each test and a control of 0.2 cubic centimeter for anticomplementary action. Only one antigen was employed, instead of three as practiced by Hinton. The tests were made with a cholesterinized alcoholic extract of guinea-pig's heart used in doses of 0.1 cubic centimeter of a 1 + 4 dilution. This

antigen was not anticomplementary with twice the amount used in the test. Normal and syphilitic sera were used as controls. In interpreting the results, both with lipoidal antigen and with bacterial suspensions, 4+ indicates no hæmolysis; 3+, faint hæmolysis; 2+, strong hæmolysis; and 1+, almost complete hæmolysis.

For a comparative study of the reaction in untreated and treated cases three groups were selected, all of the nodular or mixed type. In the first group were 13 clinically and bacteriologically positive cases who had received no treatment; in the second, 14 cases who had been receiving injections of chaulmoogra oil or its products for several months but were still clinically and microscopically positive; in the third, 16 who had become bacteriologically negative after varying lengths of time under similar treatment. These three groups are tabulated in Tables 1, 2, and 3.

The total number of cases is small, but the results, as far as they go, are definite and significant. In the group of untreated cases the percentage of positives was the average, that is, 60; in the second group the percentage is considerably higher, indicating the possibility of an increase in strength of complement-fixing substances during treatment, perhaps analogous to the so-called "provocative reaction" in syphilis. Finally, the sixteen cases of the third, or bacteriologically negative, group all allowed complete hæmolysis.

TABLE 1.—*Cases of untreated clinically and bacteriologically positive nodular and mixed cases of leprosy.*

Case No.	Age.	Duration of illness.	Wassermann reaction.
	Yrs.	*Yrs. mos.*	
1	60	3	—
2	24	2 0	—
3	21	4 0	—
4	50	3 0	1+
5	20	10	1+
6	20	1 0	—
7	26	4	—
8	19	5	2+
9	35	12 0	4+
10	28	7 0	3+
11	33	1 0	3+
12	50	3 0	4+
13	28	2 0	3+

TABLE 2.—*Nodular and mixed cases of leprosy receiving treatment but bacteriologically positive.*

Case No.	Age.	Duration of illness.	Treatment period.	Wassermann reaction.
	Yrs.	*Yrs. mos.*	*Mos.*	
1	32	4 0	3	—
2	63	3 0	4	2+
3	19	1 0	2.5	3+
4	20	4	3	(a)
5	23	2	2	4+
6	25	2 0	2	4+
7	18	3	2	3+
8	28	6	1	4+
9	22	2 0	1	1+
10	22	1 0	5	1+
11	50	20 0	5	3+
12	27	3 0	4	3+
13	20	2 0	2	4+
14	30	3	1	—

[a] Anticomplementary.

TABLE 3.—*Nodular and mixed cases of leprosy bacteriologically negative after continuous treatment.*

Case No.	Age.	Duration of illness.	Treatment period.	Wassermann reaction.
	Yrs.	*Yrs. mos.*	*Mos.*	
1	43	(?)	9	—
2	32	2	2	—
3	45	1 0	(?)	—
4	24	4 0	(?)	—
5	38	10 0	4	—
6	22	(?)	16	—
7	27	3	10	—
8	47	4 0	8+	—
9	23	(?)	36	—
10	19	3 0	18	—
11	55	(?)	9+	—
12	78	2	19	—
13	32	(?)	2+	—
14	48	(?)	3+	—
15	19	(a)	15	—
16	20	3	15	—

[a] Two weeks?

These tests were performed on two occasions and each time samples of sera from the three groups were examined simultaneously, so that variations in technic were reduced to a minimum, and the chances of accidentally finding sixteen consecutive

negative cases when more than half of similar groups were positive are neglible. It seems evident that with continuous treatment, progressive clinical improvement, and disappearance of acid-fast organisms from accessible parts the substances fixing complement with lipoidal antigen are lost gradually.

TABLE 4.—*Percentage of positive Wassermann reaction in the three groups.*

Groups.	Cases.	Positive.	Positive.
			P. ct.
Untreated	13	8	61.5
Treated, bacteriologically positive	14	11	84.6
Bacteriologically negative	16	0	0

Much of the interest in the Wassermann reaction in leprosy has been stimulated by a desire to determine if positive reactions are due to an associated syphilitic infection. As a result numerous observations have been made on the effect of salvarsan on the positive reactions of lepers. Rocamora(8) observed no change in the reaction under prolonged treatment; a similar result was noted by Veillon and Lagane;(9) while Jeanselme and Vernes(5) state that a positive reaction continuing during treatment with salvarsan is useful in distinguishing between leprosy and syphilis.

Five cases of leprosy from the untreated group, three of whom had a strongly positive reaction and two a weakly positive, received injections of mercury for six weeks, and at the end of this period there was no change in the strength of the reaction in any of them.

The presence of a positive Wassermann reaction in leprosy in the majority of cases must be assumed to be a result of infection with *Bacillus lepræ;* the disappearance of positive Wassermann reaction appears to be a specific phenomenon associated with improvement in clinical signs and diminution in number of the acid-fast bacilli, the reaction not yielding to syphilitic therapy.

There are several considerations, however, which eliminate the Wassermann reaction from useful application as a measure of the effect of treatment in leprosy. The first of these is the small proportion of untreated cases which give a positive reaction, and the large proportion of weak fixations among those that do; for one of the most essential features of a successful test of this sort is that it be positive in practically 100 per cent

of cases and, preferably, strongly positive. Another disadvantage is the confusion which arises in excluding, in positive cases, possible associated infection with syphilis and, in many tropical countries, with yaws. It would be impracticable to resort to the therapeutic test to eliminate the possibility of these diseases in interpreting the reaction.

Interesting and important as the fact is, from an immunological standpoint, that sera of lepers become negative under treatment directed against the specific infection and do not yield to antisyphilitic drugs, it seemed useless to attempt an elaboration of the Wassermann reaction in the hope of utilizing it as a measure of the response of lepers to treatment. Consequently, investigation was made of the availability of other antigens for this purpose, namely, bacterial suspensions.

COMPLEMENT FIXATION WITH BACTERIAL ANTIGEN

Although extracts of various tissues, leprous and nonleprous, as antigens have in the hands of previous investigators given somewhat higher percentages of positive results than lipoidal antigens, as used in the Wassermann test, no investigation was made of these substances in view of the more-promising results reported from the use of bacterial suspensions, especially of *Bacillus tuberculosis* (human).

It is not surprising that complement fixation occurs with leprous serum in a certain proportion of cases in the presence of antigens of various acid-fast and even certain non-acid-fast organisms, in view of the experimentally demonstrated cross fixations with the sera of animals immune to a single species of the acid-fast group and antigen from various related bacteria. The subject of cross fixations with serum of animals immunized to acid-fast organisms has been investigated by Gengou,(3) Much and Leschke,(7) Claypole,(1) and others, and there has been a small number of investigations in which various bacterial antigens, especially of the acid-fast group, have been used in complement-fixation tests with leprous serum. These have been tabulated and discussed by Cooke who has added his own observations. The result of these studies has shown that bacillary suspensions are better antigens in complement-fixation tests with leprosy than lipoidal antigens or tissue extracts. In Cooke's series of experiments with sera from twenty cases of leprosy, in which antigens prepared from suspensions of eighteen different organisms, for the most part of the acid-fast group, were used, that of *Bacillus tuberculosis* (human) gave the

best results, yielding a positive test in 100 per cent, although five cases required 0.2 cubic centimeter of serum for fixation. One serum fixed complement with this antigen in 0.0005 cubic centimeter quantity. *Bacillus tuberculosis* of bovine and avian types and *B. smegmatis* were also excellent antigens, and several acid-fast organisms isolated from leprous lesions served almost equally well.

Before selecting *B. tuberculosis* (human) as an antigen for the following tests, antigens composed of four other organisms were compared with it. These organisms were two very distinct strains of streptothrices, *B. smegmatis*, and the mist bacillus. Antigens were prepared uniformly as follows:

The organisms were grown on glycerinated broth (in the case of *Bacillus tuberculosis* on glycerinated agar also), the culture suspended in broth, and precipitated by the addition of an equal volume of 95 per cent alcohol. The precipitate was removed by filtration or by centrifuging, and dried over sulphuric acid. It was weighed and ground in a mortar with sufficient sodium chloride so that, by the addition of distilled water, a 2 per cent isotonic suspension could be made. The 2 per cent suspension was shaken thoroughly with glass beads and used as stock antigen. In performing the test a 1 to 10 dilution was used. One cubic centimeter of this dilute antigen was not anticomplementary, and 0.5 cubic centimeter was used as the antigenic dose in each test.

Table 5 illustrates the relative value of these antigens with sera from five cases of nodular leprosy. Streptothrix II is a non-acid-fast organism, and Streptothrix I is acid-fast only in certain forms.

TABLE 5.—*Comparative complement fixation with leprous serum and bacterial suspensions.*

Case.	*Bacillus tuberculosis.*	Streptothrix I.	Streptothrix II.	*Bacillus smegmatis.*	Mist bacillus.
1	4—	4—	3—	3—	2+
2	4—	4—	2—	2—	1+
3	4—	4—	3—	3—	3+
4	4—	0	0	0	0
5	4—	0	0	0	0

The observation was made by Cooke that the value of a particular acid-fast organism as an antigen depends very largely on the physical character of its suspension in salt solution. The finer and more nearly even suspensions yielded the better results.

This appeared to be the case with the organisms in my experiments. The strain of *B. tuberculosis* was an old laboratory culture of low virulence and formed a good uniform milky suspension, while suspensions of *B. smegmatis* and mist bacillus were coarsely flocculent. The physical character of the antigen is undoubtedly one of the most important considerations in selecting one of several strains of *B. tuberculosis*. That used in the following tests was especially satisfactory in this respect.

Having selected *B. tuberculosis* (human) as the most suitable antigen, it alone was used in subsequent tests to compare the complement-binding strength of bacteriologically positive and bacteriologically negative cases of leprosy.

In the first group were sera from twenty-one cases of nodular and mixed leprosy and three of the pure, anæsthetic type. Treatment with ethyl esters of chaulmoogra oil had been begun only one or two weeks before the tests were made and as yet no noticeable clinical change could be observed, and each of the nodular and mixed cases was microscopically positive. The results of the tests are tabulated in Table 6.

TABLE 6.—*Clinically and bacteriologically positive cases of leprosy just beginning treatment.*

Case.	Sex.	Age.	Type.	Duration.		Complement fixation.
		Yrs.		*Yrs.*	*mos.*	
1	M	20	Nodular	2	0	4+
2	M	30	do		2	4+
3	M	15	do	4	0	4+
4	M	17	do		4	4+
5	M	20	do	2	0	4+
6	M	23	do		6	4+
7	M	24	do		7	4+
8	M	14	do	2	0	4+
9	M	37	do		6	4+
10	M	16	do	1	0	4+
11	M	23	do		6	4+
12	M	25	do		3	3+
13	M	50	do	3	0	4+
14	M	27	Mixed	6	0	3+
15	M	17	do	5	0	4+
16	M	59	do	1	0	3+
17	M	24	do	1	0	4+
18	M	30	Nodular		11	4+
19	M	33	do		6	4+
20	M	30	do	2	0	4+
21	M	26	Mixed	2	0	4+
22	M	40	Anæsthetic	2	0	2+
23	M	18	do	4	0	4+
24	F	50	do	16	0	3+

The second group was composed of sera from twenty cases of the nodular and the mixed types, which had become bacteriologically and clinically negative following treatment with chaulmoogra oil or its products after varying intervals. The results of the tests are recorded in Table 7.

TABLE 7.—*Clinically and bacteriologically negative cases of leprosy.*

Case.	Sex.	Age.	Type.	Duration of disease.	Duration of treatment.	Clinically and bacteriologically negative.	Complement fixation.
		Yrs.		*Yrs. mos.*	*Yrs. mos.*	*Yrs. mos.*	
1	F	24	Undetermined	4 0	(?)	1 8	1+
2	F	45	Nodular	1 0	(?)	1 8	2+
3	M	25	do	1 0	1 7	1 4	2+
4	F	43	Mixed	(?)	2 3	1 2	—
5	M	32	Nodular	1 6	(?)	1 5	1+
6	M	47	do	4 0	1 5	9	4+
7	M	38	do	10 0	1 9	9	1+
8	M	27	do	2 0	(?)	(?)	4+
9	M	55	Mixed	2 0	(?)	1 7	1+
10	M	27	Nodular	4 0	11	5	3+
11	M	27	do	3	1 4	10	1+
12	M	78	do	2	2 3	2 0	2+
13	M	45	do	4 0	1 1	6	2+
14	M	48	do	1 0	(?)	1 8	—
15	M	26	do	11 0	5 11	2	4+
16	M	49	do	3 0	1 7	1 4	2+
17	M	20	do	4 0	1 10	1 3	1+
18	M	38	Mixed	2 0	1 6	1 2	1+
19	M	22	do	2 0	1 11	11	—
20	M	22	Nodular	(?)	2 8	1 4	1+

It is to be observed that 100 per cent positive fixations were obtained with twenty-four sera from cases just beginning treatment and that eighteen of the twenty-one cases of the nodular and the mixed types gave complete fixation and the three remaining almost complete. The three anæsthetic cases, while distinctly positive, were more variable, and they indicate, as was to be expected, a weaker reaction in this group. Comparison of these results with those in group 2, composed of bacteriologically negative nodular and mixed cases, shows a significant contrast. Of twenty cases only three gave complete fixation, two were negative, one strongly positive, and fourteen weakly positive. The conclusion is obvious that, with a gradual improvement in clinical evidences of the disease and a disappearance of demonstrable acid-fast organisms from the lesions, there is an accompanying diminution in complement-fixing substances in the serum, and the decrease may reach such an extent that they

become undemonstrable in a system designed for a maximum of 0.1 cubic centimenter of serum.

It is thus evident that the strain of *B. tuberculosis* used in these tests fulfills two important requisites for an antigen suitable for use in measuring immunologically the effect of treatment of leprosy with chaulmoogra oil and its products. In cases during early treatment it has given 100 per cent positive reactions and, for the most part, complete fixation. A very high percentage of positive results in untreated cases is a sine qua non if the method is to be of practical application. Secondly, with this antigen a measurable weakness in complement-fixing strength of sera in cases clinically and bacteriologically negative under treatment has been demonstrated, and the reaction may become negative within a reasonable time after disappearance of acid-fast bacilli from superficial lesions.

To be ideal, an antigen for this purpose should be absolutely specific for leprosy, but in this respect *B. tuberculosis* fails. For practical purposes, however, specificity of an antigen in a test to measure the decrease in complement-fixing strength is not so essential as in a similar test for diagnostic purposes, for here one starts with a positive fixation in cases already proven bacteriologically to have leprosy. In view of the close serological relation of complement-fixing substances in serum of animals immunized to various members of the acid-fast group, it is very doubtful if a specific antigen for leprosy not reacting with serum from human tuberculosis will ever be found. A complicating tuberculous infection cannot be excluded in cases of leprosy giving complement fixation with an antigen of *B. tuberculosis*. This, however, is not an insuperable objection to the test as proposed; for the majority of cases showing no clinical evidence of active tuberculosis will presumably, according to the above observations, show a diminution of complement-binding strength with improvement of leprous lesions, in which case active tuberculosis may be excluded. Those cases in which a complicating active tuberculosis is a factor in producing complement fixation, provided the tuberculous infection improves with the disappearance of leprous lesions, may show a weakening or a loss of complement fixation; for it has been observed that the strength of a positive reaction in tuberculosis appears to bear some relation to the severity of the disease, and reactions becoming gradually weaker until they became negative have been frequently noted(6) with clinical improvement and "cure." Under these circumstances the test will still be a valuable index

of the response of the patient. In case the reaction remains strongly positive and shows no tendency to weaken even after clinical "cure" of leprous foci, a complicating tuberculous infection should be suspected.

The antigen used in the above tests allows complete hæmolysis with syphilitic sera strongly positive with lipoidal antigen; consequently, a positive reaction offers no confusion with a coincident syphilitic infection. With many normal sera, and sera from various other diseases, the reaction has been uniformly negative. No test was made with tuberculous serum, though presumably the reaction would be positive.

DISCUSSION

A reliable serological method of measuring the response of leprous patients to treatment with chaulmoogra oil and its products would add invaluable data to the present evidences of clinical improvement and of the disappearance of acid-fast organisms from superficial lesions. An ideal method would be a specific complement-fixation test that would be positive in 100 per cent of untreated cases and that would become negative only after complete cure. It is futile at the present time to hope to obtain an antigen specific for leprosy; but the need is important enough to stimulate thorough investigation of antigens which may prove of practical value. The observations recorded above show that the Wassermann reaction is hardly worthy of further investigation as a possible test of broad application in leprosy, although of considerable immunological interest. *Bacillus tuberculosis* of the human type has given promise of being an antigen that may be of service, and thorough investigation of it is strongly recommended.

The sera of bacteriologically positive cases of leprosy contain complement-binding substances which react with suspensions of various acid-fast organisms, and especially well with *B. tuberculosis,* having yielded 100 per cent positive fixations in a series of twenty-four cases. The physical character of the bacillary suspension is of importance in selecting a suitable strain of *B. tuberculosis;* those forming the finest and most homogeneous suspensions will undoubtedly prove to be the best antigens, and it would be inadvisable to begin a series of studies unless a suitable strain fulfilling this requirement be used.

An extensive study of the subject has not been permitted, but there are certain very definite lines of investigation which are suggested by the results already obtained. It would seem important to titrate the sera of leprous cases before treatment is instituted to determine whether or not a relation exists between

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A POISONOUS CONSTITUENT IN CHOLERA STOOLS

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The histopathology of the intestine in cholera indicates that if poisonous materials are produced in the intestine, directly or indirectly as a result of the growth of vibrios, they are formed within the lumen of the bowel and not on an inflamed and denuded mucosa, for cholera vibrios are not primarily invaders of tissue. This is in contrast to the lesions found in infections with such toxin poducers as *Bacillus diphtheriæ* and *B. dysenteriæ* which regularly produce local necrosis, and which elaborate their poisonous products on and within inflammatory exudate. It is in contrast also to the effect of infection with *B. typhosus*, which brings about not only a local necrosis but also a bacteriæmia.

The vibrios of cholera do not produce an exotoxin and they do not cause septicæmia, two sources of profound intoxication which may be eliminated; and search for the poisonous agent of the disease has led most investigators to the conclusion that it is the endotoxin which has been demonstrated to exist in the substance of these organisms. Pfeiffer was unable to demonstrate a soluble toxin in young broth cultures, but showed that young killed cultures were very toxic. Wasserman confirmed this finding and showed that the toxin exists as a constituent of the bacterial cell, becoming soluble only by disintegration of the cellular body. Strong(1) also demonstrated an intracellular toxin, and found that much of it was destroyed by heat at 60° C. and that it appeared to be completely destroyed by boiling. He suggests that the stage of most violent symptoms in human cholera may coincide with a period during which rapid dying off of spirilla and, possibly, the setting free of the largest amount of toxic substance occur.

The sudden and often violent onset of the disease with early collapse, fall in blood pressure, low body temperature, and loss of fluid through the intestine are sufficiently unique to suggest the possibility of a fundamental element in the pathogenesis of

cholera which is lacking in other infectious diseases. Indeed, these symptoms have a greater similarity to those of high intestinal obstruction than to another enteric infection. Not only may the above symptoms of profound intoxication be in evidence in acute ileus but there is also a great loss of fluid through the intestine; much of it may be vomited, and at autopsy, especially in paralysis of the intestine, it may fill and distend the small bowel, particularly the upper portions.

Whipple(2) has been able, by alcoholic precipitation, to isolate from the fluid in experimentally closed duodenal loops a toxic substance which, injected intravenously into dogs in small amount, produces profound collapse and other symptoms of duodenal obstruction.

It has been possible, by precipitating with alcohol filtered watery stools and intestinal fluid from cases of cholera, to demonstrate the presence of a similar poisonous substance producing, when injected intravenously or intraperitoneally into dogs, a train of symptoms and pathological changes identical with those caused experimentally by poison from closed duodenal loops. It was to be expected, with the excretion of quantities of fluid in cholera, that whatever dissolved poisonous material might exist would be considerably diluted, and this is the case with the toxic material which has been demonstrated. The degree of toxicity was first estimated by intravenous injection of intestinal fluid removed at autopsy from the ileum three hours post mortem.

EXPERIMENT 1

November 29. Four hundred cubic centimeters of watery mucus-containing fluid were removed from the ileum three hours after death from a case of typical cholera, bacteriologically positive, dead two days after onset. Within one hour fluid was placed in ice box at 5° C.

November 30, 3 p. m. Ten hours later 150 cubic centimeters were placed in a flask in boiling water for a half hour. Precipitate removed by centrifugalization. Supernatant fluid acidified weakly to litmus with acetic acid, boiled, and the light flocculent precipitate removed by centrifuging.

At 3 p. m. 100 cubic centimeters of the clear brownish fluid were injected intravenously, under morphia and ether anæsthesia, into an adult dog weighing 8 kilograms. There was a gradual fall in blood pressure and an increased pulse rate, but no vomiting or diarrhœa. The animal died during the night,

apparently from morphia intoxication as it did not recover completely from anæsthesia.

It was evident from this experiment that in 100 cubic centimeters of fluid thus treated only a small quantity of toxic material was present. In the remaining experiments a light flocculent precipitate was removed from the intestinal fluid by the addition of alcohol, and this fraction redissolved and injected into dogs was found to be toxic.

EXPERIMENT 2

Two hundred cubic centimeters of fluid, prepared from the sample used in the above experiment, exactly in the same way, was strongly acidified with 2 cubic centimeters of glacial acetic, and an equal volume of 95 per cent alcohol added. An abundant flocculent precipitate resulted which was separated by centrifuging, washed twice with 95 per cent alcohol, once with absolute alcohol, and once with ether, pressed between filter paper, and dried; weight 0.3 gram. Most of this material dissolved on warming in 20 cubic centimeters of water made alkaline with sodium carbonate. A small undissolved residue was centrifuged off. The supernatant fluid was injected intravenously into a dog weighing 7 kilograms, under light ether anæsthesia, at 10.30 a. m. At 11 a. m. the animal had recovered from the anæsthesia. He was vomiting bile-stained material; respiration was deep and labored, pulse weak. Salivation was noticeable and a little later tenesmus with the passage per rectum of a small amount of mucus-containing fluid. At 12 noon his condition was improved, and recovery followed.

The substance recovered by alcoholic precipitation evidently contained toxic material, but this fluid removed from the intestine post mortem contained much more proteid than the watery discharges from patients early in the disease, and the alcoholic precipitation recovered from the latter proved to be more toxic.

EXPERIMENT 3

From 500 cubic centimeters of clear amber colored stool with flakes of mucus on the surface, from a typical case of cholera one day after onset, 0.355 gram of dried alcoholic precipitate was recovered. The original fluid stool was strongly alkaline. It was acidified weakly to litmus with acetic acid, and boiled. A light flocculent precipitate was removed by centrifuging. To the remaining supernatant fluid (500 cubic centimeters) two volumes of 95 per cent alcohol were added.

The precipitate removed by centrifuging was washed twice with 95 per cent alcohol, once with absolute alcohol, once with ether, and then dried. Two hundred milligrams of the dried precipitate were dissolved in 10 cubic centimeters of water made alkaline to litmus with sodium carbonate. A small fraction remaining undissolved was removed by centrifuging. This solution was injected intravenously into an adult dog weighing 4.2 kilograms, under light ether anæsthesia.

Before injection, pulse was 110; respiration, 20; rectal temperature, 39° C.

11 a. m. Solution injected slowly. Began to heave during injection. Shortly afterward pulse was weak and mucous membranes pale. Came out of anæsthesia slowly. Bowel movement consisted of hard fæces. Got up and moved position. Listless and sick.

12.30 p. m. In complete collapse. Did not resist changes in position. Muscles flaccid. Had voluminous fluid stool containing flakes of mucus. Profuse salivation. Pulse 90, respiration 24, rectal temperature, 37.5° C. Had rigors with stiff legs and neck.

1.00 p. m. Dead. Had more fluid bowel discharges. Autopsy showed general splanchnic congestion, with intense, brick-red congestion of duodenal mucosa, the intensity gradually fading off about 2 feet below the pylorus. Lumen of small intestine filled with bile-stained fluid and mucus. Colon pale and filled with fluid. Livér congested. Gall bladder injected and œdematous. Heart's blood clots very slowly.

In another experiment 0.3 gram of dried precipitate from a different case injected into a dog weighing 5.6 kilograms was fatal in one hour, with symptoms and pathological changes the same as those described in experiment 3. In a third, 0.4 gram was injected into a dog weighing 6.6 kilograms followed by similar symptoms but resulting in recovery. Sublethal doses of several other preparations of dried alcohol precipitate were used; the estimated fatal dose varied in different ones, but was about 0.1 gram per kilogram.

In the following two experiments unboiled fluid was used, and this seemed to be more toxic than fluids subjected to greater heat.

EXPERIMENT 4

Fifteen hundred cubic centimeters of fresh fluid stools from cholera patients, within two or three hours after passage, were heated in flasks, immersed in boiling water, for fifteen minutes.

The flasks were then placed in the ice box at 10° C. for several weeks until the material in suspension had sedimented, leaving a clear supernatant fluid. This was passed through a Mandler filter. The filtrate was water clear and amber colored. Five hundred cubic centimeters were made acid by the addition of 2 cubic centimeters of glacial acetic and two volumes of 95 per cent alcohol were added. A light flocculent precipitate separated out, estimated at about 0.2 gram. This was removed by sedimentation and centrifuging, and washed once with 95 per cent alcohol. The alcohol was decanted and the precipitate completely dissolved at room temperature in 20 cubic centimeters of water made slightly alkaline with sodium carbonate. This solution injected intravenously into a dog weighing 6 kilograms resulted in vomiting, watery diarrhœa, collapse, and death within one hour. Autopsy showed splanchnic congestion and intense reddening of duodenal mucosa.

The precipitate from an additional 500 cubic centimeters treated in the same way was injected intraperitoneally at 10 a. m. into a dog weighing 5.5 kilograms. There followed almost immediate collapse, fall in blood pressure, labored respiration, urination, and tenesmus. At 11.30 a. m. collapse continued. Passing watery discharges from bowel. Pulse could not be felt at 12 noon. Copious fluid fæcal discharges. Vomited blood-stained fluid. Convulsions. 12.30 p. m., dead. At autopsy an intense congestion of the intestinal mucosa was found, although the peritoneal surfaces were pale and smooth. Large, irregular, brick-red splotches of congestion were distributed throughout the mucosa of the small bowel. Mucosa of colon congested.

Since the fluid stools from cholera patients contain practically no proteid precipitable by heat and acetic acid, the above method of preparing the alcohol precipitate from water-clear fluid which has passed through a diatomaceous filter is much the best. Even an initial heating to sterilize the fluid is not absolutely necessary; initial heating may destroy some of its toxicity but was uniformly done in these experiments as a precautionary measure. It has been found more difficult to dissolve the dried precipitate than that washed once with alcohol, and the washed preparations appear to be more toxic.

No attempt has been made to purify the poison contained in the fæcal precipitate, and it is undoubtedly brought out of solution along with other substances. Precipitation from an acid solution is much easier than with the natural alkaline reaction. Four volumes of alcohol or more are necessary with

fluid which is alkaline, while two volumes cause complete flocculation in a very short time when it is strongly acidified with acetic acid.

DISCUSSION

Even in the crude form obtained by this method the precipitated substance is much more toxic than are most preparations of proteoses and peptones which ordinarily are lethal for dogs only in doses of 0.5 to 1 gram per kilogram. The blood-pressure reaction is also different, in that there is a more-gradual and prolonged fall. In other respects the intoxication is similar to that produced by the products of proteid digestion; namely, salivation, vomiting, diarrhœa, and incoagulability of the blood.

Even though this experimental collapse with its attendant symptoms is produced in a very artificial manner it has, nevertheless, a certain resemblance to the manifestations of the more-violent cases of cholera in man, as well as to those of high intestinal obstruction. There is nothing specific about the symptoms produced experimentally; they are common no doubt as a reaction to a number of products of proteid disintegration. It is, however, suggestive that a poisonous material giving such a reaction is present in cholera stools.

The conditions under which poisonous products of proteids are found are those in which body proteids or bacterial proteids may be rapidly broken down. Such is the situation in high intestinal obstruction and in experimentally closed duodenal loops. Bacteria proliferate in enormous numbers in a location where normally but few occur, and in this situation are the active proteolytic ferments of the body from pancreas and intestinal mucosa. The conditions are certainly favorable for a rapid splitting up of both body and bacterial proteids.

It seems not altogether unwarranted to see in cholera an analogous condition. In this disease there is certainly a prolific growth of vibrios in the small intestine in its upper portions as well as in its lower. They grow readily in alkaline intestinal juice, where normally there are practically no bacteria. In cultures, and perhaps in the intestine, they reach a maximum growth in from twelve to twenty hours, after which rapid death takes place. It would seem entirely possible that at this stage their bodies are disintegrated by the action of proteolytic enzymes with the liberation of toxic split products.

The toxic material isolated by alcoholic precipitation may be formed in this way. Although considerably diluted by intes-

tinal fluid, it can nevertheless be demonstrated in sufficient quantity to be a possible factor in the disease. Post mortem more than a liter of fluid may be present in the small intestine, which would contain at least 1 gram of alcoholic precipitate, or more than enough to kill a dog, weighing 10 kilograms, when injected intravenously.

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ALEXANDER SCHADENBERG, HIS LIFE AND WORK IN THE PHILIPPINES

By OTTO SCHEERER

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ONE PLATE

Botanists and zoölogists in the Philippines know of a number of plants and animals that bear specific names derived from the family name of their discoverer, Schadenberg, and the ethnographer not unfrequently comes across this appellation in his literature on Luzon, Mindanao, and Mindoro; yet, of the man who bore that name practically nothing is known to the present generation of residents in the Islands. It may therefore be of interest to present here a short biographical sketch of this precursor of our present-day research workers, a man who in his day sealed his devotion to the scientific exploration of the Philippines with his life.

Alexander Schadenberg was born in Breslau, Germany, on June 27, 1851, the son of a court dignitary.[1] After graduating from the gymnasium of that city he was apprenticed for some time to a local pharmacist and later, with the practical knowledge thus acquired, entered Breslau University for the study mainly of chemistry, pharmacy, and botany. His great talent and predilection for all branches of the natural sciences soon made him a favorite with his teachers, among whom were such eminent men as Goeppert, the botanist. His record in chemistry under Doctor Loewig was so excellent that at the early age of 23 years, young Schadenberg, having achieved the degree of Doctor of Philosophy, was appointed assistant director of the Potassic Salt Works at Stassfurt, where he worked until 1876 to the satisfaction of his employers. An inborn longing, however, for the exploration of unknown countries overseas did not allow him to remain long at home. A position as chemist being

[1] I am following notes kindly furnished me by a member of Schadenberg's family now living in Europe, but I see that Blumentritt in an obituary notice in Int. Arch. f. Ethn. Leyden 5 (1896) 151 gives the date of birth as May 27, 1852.

offered him by the wholesale drug firm of Pablo Sartorius in Manila, he accepted the post and bade good-bye to his native land.[2]

He remained with this firm for three years and indicated his interest in the exploration of the Islands by a number of excursions into the interior, visiting among others the Negritos of Bataan, Zambales, and Pampanga. A severe attack of a pernicious fever compelled him to return to Breslau in 1879, not, however, without having previously worked out with a Manila friend, Otto Koch, a plan for the exploration of southern Mindanao, especially the country around Mount Apo on Davao Gulf. For a while the execution of this plan seemed endangered by Schadenberg's engagement, in the spring of 1881, to a young countrywoman of his. The interest, however, which all parties concerned took in the projected expedition, from which valuable results were expected for science, was sufficient to induce the young couple to agree to a temporary separation. Thus, in August, 1881, supplied with all necessary instruments and with articles of exchange for dealing with the natives, Schadenberg set out again for the Philippines, accompanied by his friend Koch. In Mindanao the Spanish authorities of those days, while ready to lend every possible help, showed themselves sincerely concerned about the safety of the travelers intent on losing themselves in the wilds of the country behind Davao, a region which in parts remains unexplored even to-day. By December, however, the two friends had established themselves beyond the pale of civilization, in the Bagobo village Sibulan, south of Mount Apo, where, in exchange for some coils of brass wire, they had purchased the handsome bamboo cottage of one of the headmen. During their stay here of about six months they made the tribe among which they lived, and which was notorious for the practice of human sacrifice, the object of a close ethnographic study, drawing up also a vocabulary of the language.[3] They assembled an extensive collection, both of ethnographic objects and of specimens of the local flora and fauna,

[2] An uncle of Pablo Sartorius, F. Steck, was the first to devote himself in Manila to the distillation of ilang-ilang oil [Pharm. Zentralh. 9 (1868) 46]; the Sartorius brand of this essence, then the object of a flourishing industry in Manila, came to acquire a worldwide fame.

[3] This vocabulary contains among other things the native names of nine plants; also of forty-two birds, the skins of which Schadenberg brought home.

securing of butterflies alone some 20,000 specimens which they collected with the help of a young Bagobo specially trained by them for this work. From Sibulan as a base, they undertook a number of exploring trips into the surrounding country; the especially notable expeditions were two successful ascensions of Mount Apo [4] on February 20 and March 16, 1882, and a trip to the mountain Párag, north of the volcano, which led to the discovery of a new species of *Rafflesia*, a giant parasite, the open flower of which measured 80 centimeters in diameter; this species was afterwards called *Rafflesia schadenbergiana* Goeppert.[5]

The expedition to Mindanao ended with an exploration of the burial caves on the small island of Samal, which was greatly facilitated by the authorities at the Spanish Naval Station at Davao, who placed the gunboat *Nuestra Señora del Buen Viaje* at the disposal of the travelers. The exploration of this island was not less successful than had been that of the hinterland of Davao, and Schadenberg enriched his collections with a number of skulls, prehistoric dugout coffins, and many specimens of equally old Chinese pottery.

The end of July of the same year saw Schadenberg and his treasures back in Breslau. It was his intention, after having established his family, to dedicate himself primarily to the working over of his collections. Unwilling to bind himself to any institution or museum, he secured the financial support for such work by purchasing the Hofapotheke [6] in Glogau, Silesia, where he spent the following three years (1883 to 1885). It was mainly during this time that he entered into friendly relations with several European museums and was made corresponding member of various anthropological and ethnographical societies in Berlin, Vienna, Dresden, Leyden, and Paris. Official recognition of his scientific zeal was given by the bestowal of some orders and crosses. His publications on the results of his trips he supplemented with a number of lectures;

[4] On Mount Apo the explorers, at each of their ascents, left their cards on the very apex in a bottle, placed neck down in the ground, one of which was found some nineteen years later by Phelps Whitmarsh, as related in his "Ascent of Mount Apo," The Outlook, March 23, 1901.

[5] Two rather young buds of this plant growing close together on a stem, when roughly weighed in the field, were balanced by a heavy double-barreled rifle and six solid bullets.

[6] A drug store, given official distinction by such title.

at the Anthropological Congress, held under the presidency of Virchow in Breslau in 1884, he spoke on the artificial deformation observed in ancient skulls found by him on Samal.

All this but served to maintain and increase his desire for further exploration in the Philippines. When, therefore, upon the death of one of the partners of Pablo Sartorius in Manila, he was offered the place thus vacated, he accepted it, the more readily as his destination this time was to be not Manila whose climate had before proved disastrous to his health, but the more salubrious Vigan, the capital of Ilocos Sur, where he was to manage a branch of the Manila office, and from where he hoped to carry out certain plans for the exploration of northern Luzon.[7] He arrived with his family in Vigan in November, 1885, and the next year he made his first expedition into the Cordillera Central where he visited the people of Balbalásan, Pagpagó, Gináang, Lubuagan, and other mountain settlements, situated in what to-day is Kalinga Subprovince. In the following year (1887) he went to Bontok, Talubin, Banawe, Sapao, Asin, Lahutan, and Suyuk. In the absence of details of his itineraries it is impossible to give the exact route taken by him in this and in other expeditions. In the present instance, however, we have his letter from Vigan, dated October 10, 1887, to the Anthropological Society in Berlin, in which he says:

> I have so far visited in detail the inhabitants of the provinces of Abra,[8] Bontok, Lepanto, La Union, and parts of Nueva Vizcaya and Isabela. The much-discussed question of [classifying] the Igorots I dare not approach yet; this problem they solve in Europe with more ease than we here on the spot. * * *

From the photographs taken by Schadenberg among the mountain tribes of northern Luzon, a collection of which is now in the possession of Prof. H. Otley Beyer, it becomes evident that Schadenberg at some time passed also through Benguet Subprovince, traveling with his wife through the valley of Agno River. But the most courageous advance made by him into the interior of the mountain region was undoubtedly his expedition into the country of the head-hunting Apayaos, undertaken in

[7] Another source gives him as owner of the drug store in Vigan directly purchased by him from the Manila firm with the preconceived object of carrying out from this base his plans for the exploration of northern Luzon. It may be pointed out here that Schadenberg was in the habit of financing all his expeditions from his personal means, acquired chiefly as the result of previous professional labors.

[8] Abra was at that time reckoned to extend farther east than at present.—Translator's note.

1889, just at a time when the relations between these and the Christian lowlanders were at their worst. Though habitually averse to any display of force, he had to consent, in this instance, to his Ilokano carriers arming themselves; still, after reaching the settlements around the present township of Bayag, in northern Apayao, it was not hostility on the part of the Apayaos, but much fever among his carriers that compelled him to desist from his plan to reach Malaueg in Cagayan, and return by way of the Saltan and Abra. He had, however, the satisfaction of being able to induce five of his newly won Apayao friends to come down with him to Dingras, in Ilocos Norte, where their presence caused considerable sensation. Mounted messengers having carried the news to the provincial governor, Don Manuel Sastron, in Laoag, this functionary availed himself of the opportunity to improve the existing trade relations with the mountaineers. These had consisted in a peculiar system of barter, according to which the Apayaos deposited their chief product, tobacco, at certain neutral spots and then retired, after having given advice to the "cristianos" by signs and shouts. The latter came up and deposited at the side of the tobacco bundles the estimated equivalent in native fabrics, wire, iron, and beads, and then retired in their turn, whereupon the Apayaos came forward again to inspect the articles thus offered in exchange. If these were found suitable, they took them up and left the tobacco in their place; if found insufficient, they took away part of the tobacco and left only the quantity considered a fair return for the Ilokano goods, waiting thereafter in retirement to see if the Ilokanos signified their agreement. This crude type of barter at a safe distance Sastron sought to improve by giving to Schadenberg's companions official documents authorizing them to trade freely and directly with the Christian towns and promising every support and protection.

In 1890 Schadenberg paid a short visit to his native country, returning with his family to the Philippines in the spring of 1891. The old firm of Pablo Sartorius, which had been changed to that of Boie and Siegert, now became Boie and Schadenberg. The latter was henceforth obliged to reside in Manila and, on resuming his trips into the provinces whenever he could find the time, he was warned against the danger to his health arising from his known propensity to fevers, especially those of the malarial type. Notwithstanding this, he soon developed an irresistible desire to find out more than was known at that time about the interior of Mindoro Island, in easy reach from Manila;

an ascent of Mount Halcon (2,587 meters) and a study of the Mangyans [9] were uppermost in his mind. He visited the island for the first time in 1894, and a second time in the following year, bringing back valuable results from each trip. In spite of the germs of malaria lurking in his veins, he had planned a third trip to Mindoro which was to take him to the top of Mount Halcon in 1896, when death overtook him on January 26 of that year, at the early age of forty-four years. At the time he was staying, for the sake of recuperation, at the house of his friend, the Spanish governor Cadrana in Capiz, Panay.

Schadenberg's work of exploration in the Philippines has borne fruit in a number of papers of which he was the author, as well as in a not inconsiderable literature on his discoveries by others. A bibliographical list of these works is appended and it has been made as nearly complete as possible. It finds its natural supplement in his collections, which are found in the museums of Dresden, Vienna, Berlin, and Leyden. How fruitful Schadenberg's work in the field became for the scientist confined to his study at home may be shown by an example. Considering that Schadenberg's specialization lay in the field of natural sciences, it cannot well be expected that linguistics played more than a secondary rôle with him. Yet the Negrito vocabularies collected by him in the Bataan–Zambales region were considered worth being twice made the object of very painstaking examination by such an eminent authority as the late H. Kern, of Leyden,[10] whose findings are as yet the last word that has been said regarding such interesting questions as the relation of Negrito speech to the Philippine languages, and the presence in the former of possibly unrelated elements suggesting remnants of an earlier and now extinct language peculiar to this race of dwarfs. This is also true in regard to Schadenberg's collection of Mangyan writings on Mindoro, worked over by Dr. W. Foy in Dresden.[11] Among the traits of character that so peculiarly fitted Schadenberg for his work as an explorer we distinguish, besides tenacity of purpose and fearlessness, that sterling and directly convincing integrity which alone rendered it possible for him to carry on his work in the midst of a society of Filipinos, Spaniards of all classes, and crude mountaineers with their widely divergent ideals. He was welcomed and given much aid in many a provincial convento or parsonage,

[9] For the form Mangyan see Philip. Journ. Sci. 7 (1912) 135, 157.
[10] See appended bibliography under C. 1882 and 1893.
[11] See appended bibliography under B. 1895.

and he was a personal friend of Doctor Rizal in whom he took great interest and who made him the recipient of all his writings. Above all, however, he was possessed of an almost passionate interest and zeal for scientific exploration which, when necessary, bade him sacrifice all that is generally held dear by men and which make him worthy of emulation. Honor be to his memory!

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ILLUSTRATION

PLATE 1. Alexander Schadenberg, from a photograph.

PLATE 1. ALEXANDER SCHADENBERG.

CERTAIN DEVELOPMENTAL STAGES OF ASCARIS LUMBRICOIDES OVA IN THE LIVER TISSUE

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ONE PLATE

The eggs studied in the present paper were observed by one of the authors of this article while examining a histological section of the liver of a child, 3 years old, who died of tuberculous meningitis. These ova are of particular interest, not only because of their peculiar location in the host body, but also because they seem to be at variance with the common belief that ascaris eggs are capable of segmenting only after they have passed out of the body of the host.

History of the case.—The patient was a poorly nourished, emaciated, highly irritable, female Filipino child, 3 years old. She was living with her grandmother who had pulmonary tuberculosis. The patient was admitted into the hospital with symptoms of meningitis after having been sick for nine days outside. When she was one and a half years old she had fever and chill occasionally for four months, oftentimes associated with abdominal pains, tympanism, and vomiting. Nine months later the child passed several ascarides, and since then repeatedly passed the same kind of worm, either per mouth or per rectum. About one week previous to admission she vomited one large ascaris. There was no history of colic or jaundice, nor was there any mention of passage of worms during her stay in the hospital. In this institution a lumbar puncture was performed and about 10 cubic centimeters of clear fluid with some white flocculent precipitate were obtained under low pressure. The spinal fluid was negative for tubercle bacilli, and the number of cells was 5 per cubic millimeter. The proportion of lymphocytes was 80 per cent, of neutrophiles 20 per cent.

The child died nine days after admission, after having presented a dramatic aspect of generalized convulsions, with twitching of the muscles of the face, distended and tympanitic abdo-

men, and marked hyperpyrexia, the temperature often reaching 40.5° C.

Clinical diagnosis.—Tuberculosis, generalized; meningitis, tuberculous; peritonitis, tuberculous.

Autopsy.—Autopsy was performed eighteen hours after death. Body was that of a well-developed but poorly nourished female Filipino child, 3 years old, 88 centimeters in length, and 9.1 kilograms in weight. The eyeballs were moderately protruding, the pupils equal and not dilated. The lymph glands of the neck and axillary regions were slighty palpable. The abdominal cavity contained about 50 cubic centimeters of clear straw-colored fluid. The serosa of the intestine in the last portion of the ileum showed a few minute tuberculous nodules. The mesenteric lymph nodes were considerably enlarged, and many of them contained caseous material. The lungs were moderately congested; on section they showed a few minute tubercles at the level of the apices. The peribronchial glands were slightly enlarged, and some of them contained calcareous material. The spleen was normal except for the presence of a few very minute tubercles visible on the surface of the organ.

The liver showed evidence of marked fatty degeneration. Ascarides were not found either in the gall bladder or in the bile ducts. The stomach was apparently normal. The mucosa of the last portion of the ileum showed irregular tuberculous ulcers. These were found in places just opposite the tuberculous nodules found in the serosa. No adult ascaris was found in any part of the alimentary tract. On opening the skull, the cerebrospinal fluid was found increased in amount and somewhat turbid in appearance. The ventricles of the brain were dilated and filled with turbid fluid. Laterally on the brain surface, and at the level of the base, especially along the course of the large blood vessels, a few conglomerations of minute grayish tuberculous nodules were encountered. The right hemisphere of the cerebellum was almost completely involved by a yellowish opaque tubercular mass; this was firm in consistency and on section it showed a whitish central portion apparently composed of fibrous tissue. The periphery was more yellowish in color. The cut surface of this mass showed also some minute gray nodules scattered through the substance of the tumor.

Anatomical diagnosis.—Tuberculoma of the cerebellum; tuberculous meningitis; tuberculous enteritis, ulcerative; fatty degeneration of the liver.

The histological diagnosis of the tissues confirmed the above anatomical findings.

Location and identification of the eggs.—The eggs were accidentally discovered in one of the blocks from the liver tissue; a rounded, fairly well circumscribed mass was found around a portal area, about 2 to 3 millimeters in diameter. The bile duct of this portal area was greatly dilated; the basement membrane was moderately infiltrated with rounded cells and polymorphonuclear leucocytes, and the connective tissue around it was considerably increased in amount showing at the same time evidence of endothelial cells, rounded cells, and polymorphonuclear infiltration. There were also apparently some accessory bile ducts and some blood vessels. This portal area seemed to be fused with the mass previously mentioned. The mass contained numerous eggs in various stages of segmentation. In shape, size, structure, and general appearance, the eggs in question were unmistakably those of *Ascaris lumbricoides.* They were elliptical, round or oval bodies with a thick transparent cell wall. The extra albuminous coat was invariably absent. The vitelline membrane was fairly visible in many of the ova. They measured on the average from 45 to 65 μ in length and from 45 to 50 μ in width.

The ovarian cells were in various stages of segmentation. One-cell, two-cell, four-cell, and eight-cell stages were found. In some the yolk granules were fairly visible around the segmenting ovarian cells. These eggs lay in a matrix composed of connective tissue showing evidences of necrosis, especially around the eggs. In the meshes of this connective tissue there were also numerous endothelial cells which in certain places were fused together, forming beautiful giant cells. Some of these collected around the ova trying to engulf them. Centrally, between the eggs, there were also in some places large deposits of fibrin and very few polymorphonuclear leucocytes. The peripheral portion of the mass was almost entirely composed of fairly well preserved connective-tissue cells, numerous polymorphonuclear leucocytes and endothelial cells, some eosinophiles and round cells, and a few fibroblasts.

The liver cells in the rest of the liver tissue showed evidence of marked fatty degeneration. The connective tissue of the other portal areas was also increased in amount, and infiltrated with round and polymorphonuclear cells.

The above findings, coupled with the advanced inflammatory reaction of the tissue involved, afford us no scientific basis upon which we might determine the exact location of the eggs in spite of the fact that serial sections were made of the affected area. It is probable that they were confined originally within the portal area and that the inflammatory process and necrosis extended afterwards into the parenchyma of the liver tissue. This explanation is more or less in harmony with the observations of several authors who found ascarides very frequently in the intrahepatic bile ducts; and, although in the present case the worms were not found in the bile ducts on the autopsy table, the cellular infiltration and fixed tissue reaction of the portal areas as found microscopically are factors that can be taken into consideration, and they perhaps explain within certain limits the result of the migration of the worms into the interlobular bile ducts.

On the other hand, the extensive productive inflammation and the necrosis around the ova can be interpreted as due not only to a simple mechanical factor (as any other foreign body), but probably also to the presence of some substance secreted by the worms. In this connection we might mention the names of Shimamura and Fujii who have isolated from the horse ascaris a toxic substance which consisted of a mixture of albuminoses and peptone that gives rise to toxic symptoms when injected into the horse.

DISCUSSION

The peculiar location of these eggs naturally raises the question as to how they happen to be deposited there. The absence of ascaris in any part of the alimentary tract and accessory organs at autopsy precludes the possibility of any post-mortem oviposition in that locality by migrating ascarides. The advanced tissue reaction of the part involved and the advanced stages of segmentation that the eggs have undergone, taking into consideration the relatively short time that elapsed between death and autopsy, support this view. Because of these facts we are inclined to believe that they must have been deposited ante mortem, previous to admission, in as much as there was no history of the passage of ascaris during the patient's stay in the hospital and no ascaris was encounted during autopsy.

Migration of ascarides into the common bile ducts and thence into the gall bladder or into the intrahepatic bile ducts has been frequently reported, and verified by frequent findings at operation or autopsy.

Such migration of ascarides into the different organs is attributed to the altered chemico-physical condition of the normal habitat of the parasite brought about by abnormal conditions of the host body such as high temperature in febrile affections. In the present case, it is not at all unreasonable to suppose that the high temperature concomitant with meningitis had rendered the small intestine unfavorable for the parasites and caused them to become erratic. In intestinal ascariasis, as suggested by Crowell,[1] one or more of the ascarides in the small intestine may pass through the ampulla of Vater and cause occlusion, followed by icterus, and symptoms of colic. It is true that in the present case the clinical history records no symptoms that suggest this condition, but it must be borne in mind that the marked clinical signs of meningitis might have masked other symptoms. It is possible that the worms, after ovipositing, might have traveled back to the duodenum without leaving behind any trace of their invasion exept the presence of their eggs. In this connection we might mention here Vierodt's observation, that mature female ascarides can penetrate without doubt into the liver and there deposit eggs which appear exceptionally to undergo segmentation. On the other hand, the eggs possibly laid in the common bile ducts, or in the gall bladder, might have been carried by the back flow of bile caused by some temporary occlusion into the intrahepatic bile ducts, thereby causing necrosis of the portal area and the surrounding liver tissue.

It is a matter of common knowledge among parasitologists that ascaris eggs are laid normally in the small intestine before segmentation, and are passed outside with the fæces where cleavage of the ovarian cells takes place. The occurrence of segmenting ova in such an organ as the liver, discussed in this paper, is contrary to this common belief. It also shows that a very small amount of oxygen is required to initiate segmentation. Among the eggs we studied in this paper, none was found to have passed the 8-cell stage. This seems to be in conformity with Wharton's observation[2] that "At 37° C. development will begin, but all of the eggs die either in the 4- or the 8-cell stage," if we disregard entirely the time element, which in our case is not determined. Whether or not the eggs in question could have developed in time into motile embryo stages

[1] Journ. Am. Med. Sci. 159 (1920) 380–398.
[2] Philip. Journ. Sci. § B 10 (1915) 21.

capable of auto-infecting the host is entirely a matter of conjecture; but the possibility certainly suggests itself that they could develop, as do those of *Tænia solium* and *Hymenolepis nana*.

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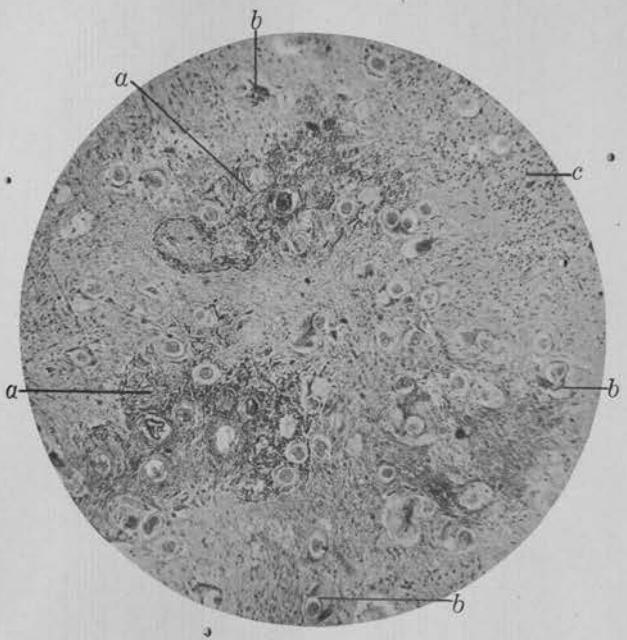
ILLUSTRATION

PLATE 1. ASCARIS IN LIVER TISSUE

FIG. 1. Photomicrograph of the area of liver involved as seen with the low power. It shows numerous eggs at various stages of segmentation; *a*, shows an amount of fibrin collected around the ova; *b*, shows beautiful giant cells trying to engulf eggs; *c*, shows the leucocytic infiltration at the periphery of the mass.

2. The same area as is shown in fig. 1, more highly magnified. The structure of the ova is here well demonstrated. The vitelline membrane is fairly visible as are also the segmenting ovarian cells. The ova are surrounded by necrotic tissue showing endothelial and some polymorphonuclear infiltration.



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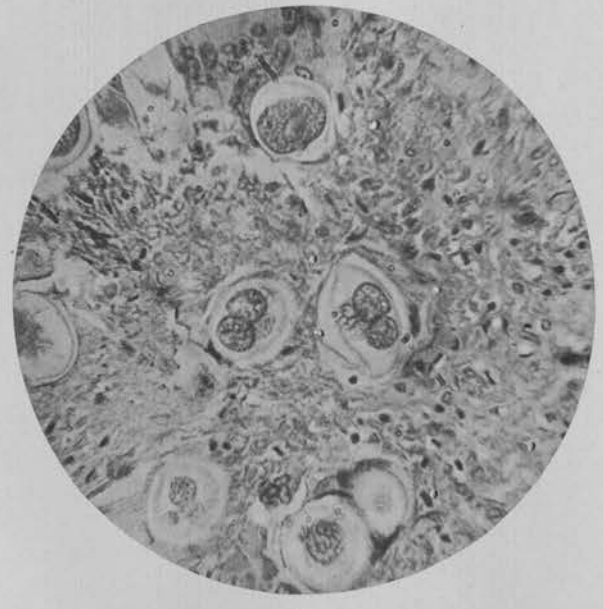

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PLATE 1. ASCARIS EGGS IN LIVER TISSUE.